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(54) **Sintered core for an electromagnetic contactor with controlled closing velocity.**

(57) An electromagnet/armature set fabricated of powdered metal is disclosed. The powdered metal is preferably magnetic and may be mixed with phosphorus to improve the magnetic properties of the powdered metal, which is molded into the desired shape by pressing and sintering. The electromagnet and armature set are especially adapted for use with electromagnetic contractor and controller motors wherein the electromagnet/armature seat against each other with a controlled closing velocity.

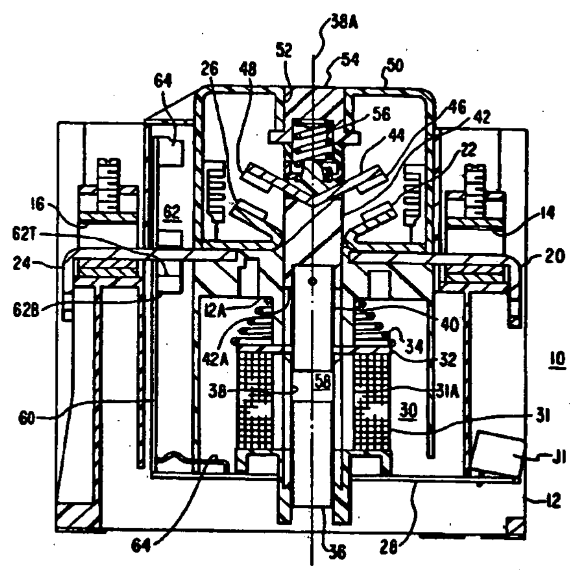

FIG. 1

EP 0 505 194 A1

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The present invention relates to magnetic contactors for use in an electromagnetic contactor or motor controller. More particularly, the invention relates to magnetic contactors used in an electromagnetic contactor or motor controller having a controlled closing velocity in which the magnetic contactors comprise an armature and an electromagnet fabricated of powdered metal.

Electromagnetic contactors are well known as disclosed in the specification of U.S. Patent No. 3,339,161. Electromagnetic contactors are switch devices which are especially useful in motor-starting, lighting, and switching. A motor-starting contactor with an overload relay system is called a motor controller. A contactor usually has a magnetic circuit which includes a fixed magnet and a movable magnet or armature with an air gap therebetween when the contactor is opened. An electromagnetic coil is controllable upon command to interact with a source of voltage which may be interconnected with the main contacts of the contactor for electromagnetically accelerating the armature towards the fixed magnet, thus reducing the air gap.

Disposed on the armature is a set of bridging contacts, the complements of which are fixedly disposed within the contactor case for being engaged thereby as the magnetic circuit is energized and the armature is moved. The load and voltage source therefor are usually interconnected with the fixed contacts and become interconnected with each other as the bridging contacts "make" or "seat" with the fixed contacts.

As the armature is accelerated towards the magnet, it must overcome two spring forces. The first spring force is provided by a kickout spring which is subsequently utilized to disengage the contacts by moving the armature in the opposite direction when the power applied to the coil has been removed. This occurs as the contacts are opened.

The other spring force is provided by a contact spring which begins to compress as the bridging contacts abut the fixed contacts, but while the armature continues to move towards the fixed magnet as the air gap is reduced to zero. The force of the contact spring determines the amount of electrical current which can be carried by the closed contacts, and furthermore determines how much contact wear is tolerable as repeated operation of the contactor occurs. It is usually desirous for the contact spring to be as forceful as possible, thus increasing the current-carrying capability of the contactor and increasing the capability of the contactor and increasing the capability to adapt for contact wear.

However, since this contact spring force must be overcome by the energy provided to the electromagnet during the closing operation, more closing energy will generally be required for relatively stiffer contact springs than for less stiff contact springs. As a result, in known contactors, the amount of energy provided to the electromagnet is more than is necessary to overcome the force of the springs against which the accelerating armature operates. One reason for this is the need to overcome the effect of the relatively stiff contact springs when the contacts engage. However, the excess energy is wasted energy which is undesirable. But, perhaps more importantly, the excess energy is absorbed by the mechanical system as the armature finishes its closing travel stroke. This excessive kinetic energy is usually exemplified by heat, noise, vibration, undesirable contact bounce and shock. The armatures and electromagnets of the prior art must generally be formed of solid, machined metal, or laminated metal in the case of AC circuits, in order to withstand the high impact seating forces. This machining and laminating is costly, labor intensive and suffers from problems of specification reproducibility.

More recently it has been discovered that it is possible to provide an electrical control system for an electromagnetic closing system which provides only the amount of energy necessary to overcome the forces which resist movement of the armature in the closing stroke. Such controlled closing devices are described in the specifications of U.S. Patent Nos. 4,720,763 and 4,893,102.

An object of the invention is to provide an armature and/or electromagnet which has been formed of powdered metal, most particularly, pressed and sintered powdered magnetic metal such as iron, in order to create a pre-determined shape useful for armatures and electromagnets.

A further object of the invention is to provide armatures and electromagnets which are formed of powdered metal and which can withstand the closing forces acting on the armature and electromagnet and which may be used in conjunction with electromagnetic contactors in motor controllers.

According to the present invention, a slug of magnetizable material and a magnetic flux conductive armature for use in an electrical contactor, in which said magnetic flux conductive armature normally spaced apart from said slug and capable of abutting said slug at a controlled abutting velocity, at least one of said magnetic flux conductive armature and said slug is formed by pressing and sintering powdered metal to a predetermined shape.

Conveniently, the armature and electromagnet are both fabricated of the powdered metal which is magnetic and selected from the group iron, cobalt and nickel and mixtures thereof.

The armature and electromagnet set are formed into predetermined shapes such as "C", "I" and "E". These shapes are prepared by pressing the powdered metal into a mold conforming to the desired shape and sintering the powdered metal to fix the armature or electromagnet in the desired shape.

Advantageously, the armature or electromagnet

may contain, in addition to metal powder, phosphorus powder to improve the magnetic properties of the powdered metal being used.

Preferably, the pressed and sintered armature and/or electromagnet is disposed within an electrical contactor and/or motor controller which utilizes a controlled closing velocity to protect the electromagnet and/or the armature from shattering upon impact.

The invention will now be disclosed, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a cut-away elevation of an electromagnetic contactor in which the armature and electromagnet of the present invention may be used; and

Figure 2 is an illustration of the various shapes in which the armature and/or electromagnet.

Figure 1 is an example of an electrical contactor or controller 10 in which the electromagnet and armature may be used is shown, comprising a housing 12 made of electrical insulating material such as a glass/nylon composition upon which are disposed electrical load terminals 14 and 16 for interconnection with an electrical apparatus, a circuit or a system to be serviced or controlled by the contactor 10. Terminals 14 and 16 are spaced apart and interconnected internally with conductors 20 and 24, respectively, which extend into the central region of the housing 12. There, conductors 20 and 24 are terminated by appropriate fixed contacts 22 and 26, respectively. Interconnection of contacts 22 and 26 will establish circuit continuity between terminals 14 and 16 and render the contactor 10 effective for conducting electrical current therethrough. A separately manufactured coil control board 28 may be securely disposed within housing 12. Disposed on the coil control board 28 is a coil or solenoid assembly 30 which may include an electrical coil or solenoid 31 disposed as part thereof. Spaced away from the coil control board 28 and forming one end of the coil assembly 30 is a spring seat 32 upon which is securely disposed one end of a kickout spring 34. The other end of the kickout spring 34 resides against portion 12A of the base 12 until movement of the carrier 42 causes the bottom portion 42A thereof to pick up the spring 34 and compress it against the seat 32. This occurs in a plane outside of the plane of Figure 1. The spring 34 encircles the armature 40, and is picked up by the bottom portion 42A of the carrier where the spring 34 and bottom portion 42A intersect. The dimension of the carrier 42 into the plane of Figure 1 is larger than the diameter of the spring 34. A fixed magnet or slug of magnetizable material 36 is strategically disposed within a channel 38 radially aligned with the solenoid or coil 31 of the coil assembly 30. Axially displaced from the fixed magnet 36 and disposed in the same channel 38 is a magnetic armature or magnetic flux conductive member 40 which is longitudinally (axially) movable in the channel 38 relative to the fixed magnet 36. At the end of the armature 40 and spaced away from the fixed magnetic 36 is the longitudinally extending, electrically insulating contact carrier 42 upon which is disposed an electrically conducting contact bridge 44. On one radial arm of the contact bridge 44 is disposed a contact 46, and on another radial arm of the contact bridge 44 is disposed a contact 48. Contact 46 abuts contact 22 (22-46), and contact 48 abuts contact 26 (26-48) when a circuit is internally completed between the terminal 14 and terminal 16 as the contactor 10 closes. On the other hand, when the contact 22 is spaced apart from the contact 46 and the contact 26 is spaced apart from the contact 48, the internal circuit between the terminals 14 and 16 is open. The open circuit position is shown in Figure 1. There is provided an arc box 50 which is disposed to enclose the contact bridge 44 and the terminals 22, 26, 46 and 48, to thus provide a partially enclosed volume in which electrical current flowing internally between the terminals 14 and 16 may be interrupted safely. There is provided centrally in the arc box 50 a recess 52 into which the crossbar 54 of the carrier 42 is disposed and constrained from moving traversely (radially) as shown in Figure 1, but is free to move or slide longitudinally (axially) of the center line 38A of the aforementioned channel 38. The contact bridge 44 is biased against the carrier 42 with the help of a contact spring 56. The contact spring 56 is compressed to allow continued movement of the carrier 42 towards slug 36 even after the contacts 22-46 and 26-48 have abutted or "made". Further compression of contact spring 56 greatly increases the pressure on the closed contacts 42-46 and 26-48 to increase the current-carrying capability of the internal circuit between the terminals 14 and 16 and to provide an automatic adjustment feature for allowing the contacts to attain an abutted or "made" position even after significant contact wear has occurred. The longitudinal region between the magnet 36 and the movable armature 40 comprises an air gap 58 in which magnetic flux exists when the coil 31 is electrically energized.

The armatures and electromagnets of the invention are shown in Figure 1 in their normally spaced apart orientation.

In a preferred embodiment of the invention, either the armature 40 or the magnet 36 or both is fabricated of powdered metal which has been pressed and sintered into a predetermined shape. Such armatures and electromagnets are adapted for use in an electrical contactor or controller 10 wherein the armature 40 seats against the electromagnet 36 at a controlled seating velocity as disclosed, for example, in the specifications of U.S. Patent Nos. 4,720,763 and 4,093,102.

The armature and electromagnet are preferably fabricated of magnetic powdered metal such as iron, cobalt, nickel and mixtures thereof. In addition to

metal powder, phosphorus powder may be added in quantities in about 0.8% by weight of the metal powder to improve the magnetic properties of the pressed and sintered armature and/or electromagnet. Other additives which may be used include carbon, copper, molybdenum and manganese.

Figure 2 (a-d) illustrates schematically several shapes into which the electromagnet 36 and armature 40 of the invention may be pressed using the teachings of the present invention. The shapes illustrated in Figure 2 are all depicted with the armature 40 being movable with respect to a fixed electromagnet 36 in the directions shown by the arrows. However, it would be possible for both the armature 40 and the electromagnet 36 to be movable.

Figure 2 (a) illustrates schematically an electromagnet and armature set wherein the electromagnet and armature each comprise a "C" shape. In Figure 2 (b), the armature 40 is an "I" shape and the electromagnet 36 is a "C" shape. In Figure 2 (c), both the electromagnet 36 and the armature 40 comprise an "E" shape. In Figure 2 (d), the electromagnet 36 is an "E" shape while the armature 40 is an "I" shape.

That shapes other than those illustrated in Figure 2 would be possible for fabricating the armature and/or electromagnet.

The armature and electromagnet may be fabricated using any acceptable pressing and sintering technique, including pressing through uniaxial and/or isostatic pressing. The armature and/or electromagnet is fabricated by pouring the desired powdered metal mixture into a mold comprising the desired shape and the powdered metal is pressed at approximately 20-60 TSI (tons per square inch) or 2812-8435 kg/cm^2 and a temperature of about 1050 to 1310 degrees centigrade. The pressed and sintered electromagnet or armature has a green density of about 6-7.5 grams per cm^3. Sintering time may vary, the longer the sintering time, the greater the reduction in size of the finished product. Sintering times of 5-60 minutes have proven adequate.

Magnetic powders which may be used include those manufactured by Hoeganaes Corporation, Riverton, N.J. under the tradename ANCORSTEEL 80P. This mixture comprises about 99.05% (wt.) iron, 0.8% (wt.) phosphorous, and about 0.15% (wt.) carbon. Advantageously, the armature and electromagnet may be fabricated and retrofitted onto existing electromagnetic contactors or motor controllers having a controlled seating velocity. Preferably, the seating velocity does not exceed about 30 inches per second in order to ensure that the pressed and sintered armature and/or electromagnet do not shatter upon seating impact.

Claims

1. A slug of magnetizable material and a magnetic flux conductive armature for use in an electrical contactor, said magnetic flux conductive armature normally spaced apart from said slug and capable of abutting said slug at a controlled abutting velocity, at least one of said magnetic flux conductive armature and said slug is formed by pressing and sintering powdered metal to a predetermined shape.

2. A slug as claimed in Claim 1 in which said powdered metal is magnetic, is selected from the group Fe, Co, Ni and mixtures thereof, and in said predetermined shapes selected from the group C, I, E, and pressed by uniaxial pressing, and/or by isostatic pressing.

3. A slug as claimed in Claim 1 or 2 in which said metal powder also includes phosphorus powder in which said phosphorus powder comprises substantially 0.8% by weight of said pressed and sintered powdered metal.

4. A slug as claimed in any one of Claims 1 to 3 in which said controlled closing velocity is no greater than about 30 inches/second, and is controlled by a microprocessor means.

5. A slug as claimed in any one of Claims 1 to 4 wherein said contactor is pressed at about 20-60 tsi at a temperature of about 1050-1310°C, and pressed and sintered powdered metal has a green density of about 6-7.5 gms/cm^3.

6. A slug as claimed in Claim 5, in which said slug is constituted as an electrical armature and electromagnet set adapted for abutting with one another from a normally spaced-apart orientation as a result of an external force acting upon said slug and/or magnetic conductive armature, said external force abutting said slug and said magnetic conductive armature against each other at a controlled relative abutting velocity, said slug and said magnetic flux conductive armature comprising magnetic powdered metal pressed and sintered into a predetermined shape.

7. A slug as claimed in Claims 5 or 6, wherein said slug and said magnetic flux conductive armature each comprise a predetermined shape selected from the group C, I, E.

8. A slug as claimed in Claim 6 or 7 wherein said magnetic powdered metal is selected from the group Fe, Co, Ni and mixtures thereof.

9. A slug as claimed in Claim 8 wherein said slug is set in a fixed position with respect to said magnetic flux conductive armature, which is moveable with respect to said slug.

10. A slug as claimed in any one of Claims 1 to 9 in which said powdered metal is doped with at least one additive selected from the group C, Cu, Mo, Mn, or mixtures thereof along with phosphorous powder.

11. A slug as claimed in Claim 10 wherein said slug comprises a fixed magnet.

12. An electrical contactor comprising first and second electrical contact means which are normally open, a slug of magnetizable material, a magnetic flux conductive armature electromagnetically abuttable with said slug and connected to said second electrical contact for closing said first and second electrical contacts, spring means for resisting closure of said first and second contacts by said magnetic flux conductive armature, and electromagnetic force generating means for causing the abutment of said slug and said magnetic flux conductive armature having a predetermined magnitude and one of said slug and said magnetic flux conductive armature comprised of pressed and sintered powdered metal having a predetermined shape.

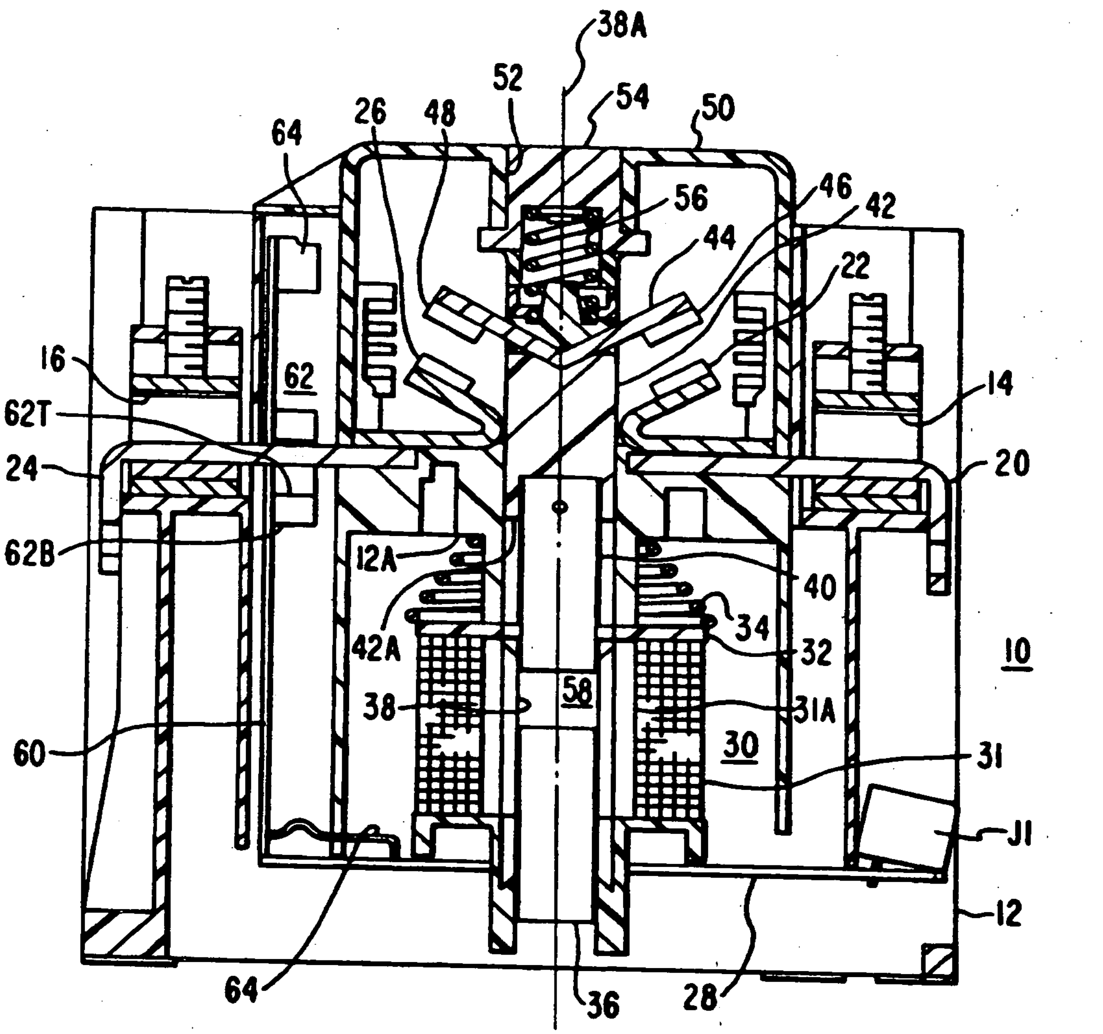
38A
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FIG. 1

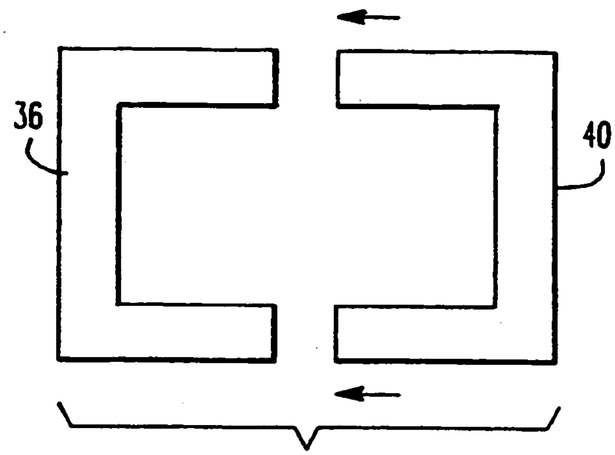

FIG. 2A

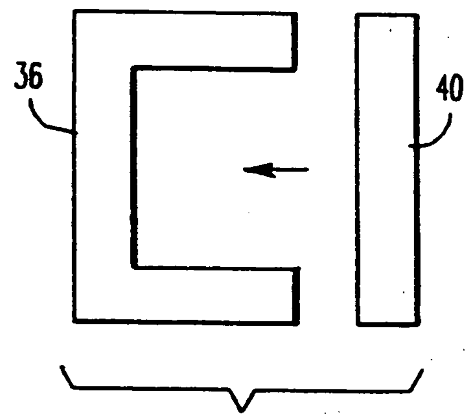

FIG. 2B

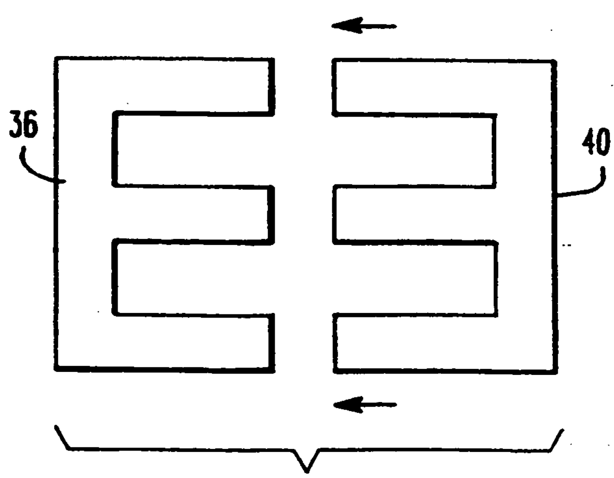

FIG. 2C

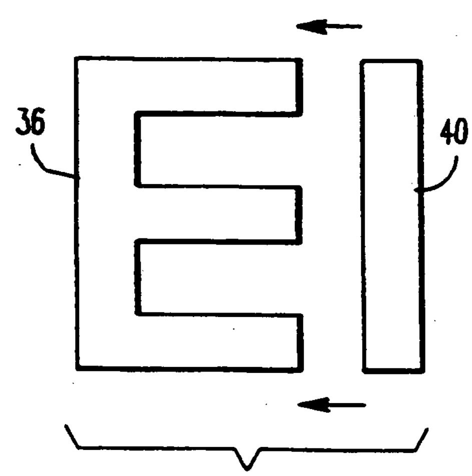

FIG. 2D

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 2396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y D	EP-A-0 279 592 (WESTINGHOUSE) * abstract; claims 1,6; figures 2,32 * & US-A-4 893 102	1-8,12	H01H50/16 H01H47/02 H01F3/08 H01F7/18
Y	EP-A-0 409 647 (SUMITOMO METAL MINING CO.) * the whole document *	1-8,12	
A	GB-A-890 142 (WESTINGHOUSE) * page 2, line 32 - line 36; figure 1 *	1	
A	US-A-4 019 239 (BOCKSTIEGEL) * column 1, line 58 - column 2, line 13; examples 1,2 *	1,2,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01H
H01F
C22C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	22 MAY 1992	NIELSEN K.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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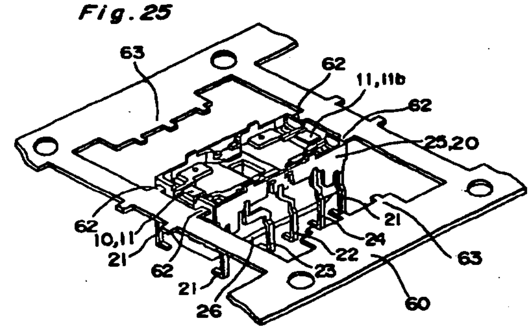
(54) ELECTROMAGNETIC RELAY AND ITS MANUFACTURE

(57) A manufacturing method for an electromagnetic relay whereby a base block 20 is monolithically molded to terminals 21 - 24 and connector tabs 62 provided in a lead frame 60. After separating the terminals 21 - 24 from the lead frame 60 and bending the terminals, a permanent magnet 30 and armature block 40 are assembled into the base block 20. A case 50 is then pressed down over the base block 20 to separate the base block 20 from the connector tabs 62 of the lead frame 60. Electrical inspection and aging treatment can thus be accomplished with the base block 20 connected to the lead frame 60, improving assembly precision and productivity.

Fig. 25



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Description

FIELD OF THE INVENTION

The present invention relates to an electromagnetic relay and to its manufacture.

DESCRIPTION OF THE PRIOR ART

An electromagnetic relay according to the prior art typically comprises an electromagnet block 2 and armature 3 placed in sequence in a box-shaped base block 1 and then enclosed by fitting a case 4 to the base block 1 as shown in Figs. 28 - 31.

More specifically, this is accomplished by first manufacturing from a hoop material by stamping and bending a lead frame 8 comprising on both long sides thereof coil terminals 6a, fixed contact terminals 6b comprising fixed contacts 7, and common terminals 6c as shown in Fig. 29. After positioning this lead frame 8 inside the cavity of a mold (not shown in the figures), said cavity is filled with a resin material to cast the base block 1. The coil terminals 6a and common terminals 6c are severed from the lead frame 8 (Fig. 30) and then bent, and the electromagnet block 2 and armature 3 are positioned in sequence inside the base block 1. The fixed contact terminals 6b are severed from the lead frame 8 and then bent, and the base block 1 is finally fit to the base block 1 to complete the manufacture and assembly of the electromagnetic relay.

The problem with this manufacturing method is related to the fixed contact terminals 6b functioning to connect the base block 1 to the lead frame 8. This prevents the fixed contact terminals 6b from being cut from the lead frame 8 during the assembly process, and electrical inspections cannot be conducted with the fixed contact terminals 6b connecting the base block 1 to the lead frame 8.

In addition, the aging treatment for eliminating the residual stress of the fixed contact terminals 6b resulting from the bending process cannot be accomplished with the base block 1 connected to the lead frame 8. A separate process is therefore required for aging the fixed contact terminals 6b, thus complicating the manufacturing process.

If in this manufacturing method the fixed contact terminals 6b are severed from the lead frame 8 after assembling the electromagnet block 2 and armature block 3 to the base block 1, deformation of the semifinished product to which the electromagnet block 2 and armature 3 are assembled may occur, reducing assembly precision. Because the fixed contacts 7 of the fixed contact terminals 6b are also hidden below the armature 3 when the severed fixed contact terminals 6b are bent, it is not possible to hold the fixed contacts 7 and it is therefore also difficult to position the fixed contacts 7 with high precision.

Low productivity also results with this manufacturing method because the case 4 cannot be fit to the base block 1 while the base block 1 remains connected to the lead frame 8, and assembly of the case 4 cannot follow continuously upon assembly of the electromagnet block 2 and armature 3.

Furthermore, after assembling the electromagnet block 2 and armature 3, and then fitting the case 4 to the box-shaped base block 1 as shown in Fig. 28, the electromagnetic relay described above must then be turned over as shown in Fig. 31 to seal the electromagnetic relay assembly by injecting a sealing agent 5 to the gap between the base block 1 and case 4 by means of an injection nozzle 9.

However, an electromagnetic relay according to the prior art as described above further comprises channels 1a and 1b formed continuously in a vertical direction in the exterior sides of the base block 1 as shown in Fig. 28. The terminals 6a, 6b, and 6c reside within these channels 1a and 1b. The presence of these channels 1a and 1b also results in a discontinuous contact face between the base block 1 and the case 4. It is therefore easy for the injected sealing agent 5 to flow through the channels 1a and 1b into the base block 1, and solidify therein. The solidified sealing agent 5 then interferes with the operation of the armature block 3, easily inducing inoperation of the electromagnetic relay. The amount of sealing agent 5 injected to the gap between the outside of the base block 1 and the inside face of the case 4 may also decrease, leading to insufficient and variable adhesion strength in the sealing agent 5.

It has therefore been proposed to use a high viscosity sealing agent as a means of reducing the free flow of the sealing agent and the problems resulting therefrom. High viscosity sealing agents, however, have a poor flow characteristic, thus increasing the time required for the injection process and lowering productivity.

If the gap between the inside of the case 4 and the outside of the terminals 6a, 6b, and 6c after bending is reduced as a means of reducing the amount of sealing agent flowing along the terminals 6a, 6b, and 6c into the case 4, strict control of dimensional precision is required; this further increases the time and cost of design and manufacturing.

It is also necessary to inject the sealing agent 5 from directly above the gap formed between the base block 1 and case 4 because the bottom of the base block 1 and the lip around the case 4 are substantially flush when assembled. Positioning the injection nozzle 9 is therefore not easy, and productivity is poor.

The desired assembly precision and mechanical strength of the electromagnetic relay according to the prior art are also difficult to obtain because the electromagnet block 2 and armature 3 are separately assembled to the box-shaped base block 1. In addition, the desired insulation characteristics are also difficult to obtain between the electromagnet block 2 and the armature 3 because of the proximity therebetween.

A fairly large quantity of sealing agent 5 is also required because the bottom of the base block 1 and the lip around the case 4 are substantially flush when assem-

bled, and the sealing agent 5 must be injected to this outside lip of the case 4.

If an electromagnetic relay of this type is mounted to a printed circuit board and the printed circuit board is then deformed by repeated expansion and contraction, this deformation cannot be absorbed by the elastic deformation of the terminals 6a, 6b, and 6c because of the shortness of the length L_2 of the terminals 6a, 6b, and 6c projecting from the lip of the case 4 (see Fig. 31), and the electromagnetic relay may separate from the printed circuit board.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a high assembly precision, high productivity manufacturing method for an electromagnetic relay resolving the problems associated with the manufacturing method of an electromagnetic relay according to the prior art by enabling electrical inspection and aging treatment to be accomplished while the base block remains connected to the lead frame.

To achieve this object, a manufacturing method for an electromagnetic relay according to a first embodiment of the present invention comprises: a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material; a process for monolithically molding the base block to the terminals and connector tabs of this lead frame; a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and a process for then causing the base block to fall from the connector tabs of the lead frame to separate the base block from the lead frame.

A manufacturing method for an electromagnetic relay according to a second embodiment of the present invention comprises: a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material; a process for positioning and then connecting an electromagnet block to a specified terminal of the lead frame; a process for postforming the electromagnet block and monolithically molding the base block to the terminals and connector tabs; a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and a process for then causing the base block to fall from the connector tabs of the lead frame to separate the base block from the lead frame.

The third and fourth embodiments of a manufacturing method according to the invention are characterized by the process separating the base block from the lead frame in the first and second embodiments above, respectively, severing the connector tabs of the lead frame as the means of separating the base block from the lead frame.

Because the connector tabs are formed separately to the terminals on the lead frame, and the resulting subassembly is then monolithically molded to the base block by means of a manufacturing method for an electromagnetic relay having any one of the first through fourth characteristics described above, the base block remains integrally connected to the lead frame by means of the connector tabs even after all of the terminals are severed from the lead frame and bent. As a result, if the internal component parts are assembled into the base block, electrical inspection is possible with the base block supported by the lead frame.

Furthermore, because the base block remains connected to the lead frame even after the terminals are severed and bent, aging treatment of the terminals is possible with the base block supported by the lead frame.

In addition, because the internal component parts are installed after severing and bending all terminals, it is not only possible to hold the fixed contacts provided on the fixed contact terminals with a tool for bending the fixed contact terminals, deformation of the semifinished product as occurs in conventional methods from cutting the terminals can be prevented. As a result, the positioning precision of the fixed contacts and the dimensional accuracy of the semifinished product are improved.

Also, because the base block remains connected to the lead frame by means of the connector tabs even after the terminals are severed from the lead frame and bent, the case and other components can be assembled continuously to the base block while the base block remains integrally connected to the lead frame. A further benefit of the invention, therefore, is improved productivity in electromagnetic relay manufacture.

A manufacturing method for an electromagnetic relay according to a fifth embodiment of the present invention further comprises a process for placing inside the cavity of the mold a spool wrapped with a coil; and directly injecting resin from the gate of the mold directly into at least one of the positioning holes provided in said spool to fill said cavity with the resin material.

By means of this fifth embodiment of the invention, the spool is accurately positioned in the cavity of the mold by the resin pressure of the resin injected from the gate of the mold. Positioning pins and clamps for positioning and holding the spool are therefore not necessary, and reduced dimensional accuracy induced by the thermal expansion of these can be eliminated.

In particular, because the spool is pressed against the base surface of the mold and thus positioned by the resin pressure of the molten resin material, not only is the need for clamps eliminated, but more flexible positioning is made possible, positioning to the best part is possible, and dimensional accuracy is improved.

Furthermore, because pins and clamps are not necessary, the internal structure of the mold is simplified, and mold production is therefore also simplified.

In addition, because the spool is pressed against the base surface of the mold and thus positioned by the resin pressure of the molten resin material, deformation of the spool and/or other components caused by compressing the mold does not occur even if there is some variation

in the dimensional accuracy of the spool and/or other components. In addition, the spool and/or other components will not become loose inside the cavity, and dimensional accuracy is improved further.

Because the resin material is also flowed into the cavity from the mold gate through a positioning hole, the gate part of the electromagnetic apparatus continuous to the mold gate is formed from extremely thick resin. As a result, it is not necessary to separately provide a thick resin part to prevent damage from demolding, and the shape of the electromagnet apparatus is simplified.

Furthermore, because the postforming resin material flows into and fills the positioning hole of the spool, etc., it is not necessary to fill the positioning hole in a later process, and productivity is thus improved.

A further object of the invention is to provide an electromagnetic relay resolving the problems associated with an electromagnetic relay according to the prior art as described above, and is characterized by enabling the simple and quick accomplishment of the sealing operation; assuring a consistent, positive seal using a small amount of sealing agent; obtaining excellent electrical insulation properties and the desired assembly precision and mechanical strength; and good resistance to separation of the terminals thereof from a printed circuit board on which the electromagnetic relay is mounted.

To achieve the aforementioned object, an electromagnetic relay according to a sixth embodiment of the invention is constructed with the terminals projecting from the top perimeter area of the outside surface of the box-shaped base block housing the electromagnet block bent downward from the terminal base; a sealing agent injected to and cured in to seal the space formed between the box-shaped base block and the box-shaped case fit to the box-shaped base block; and is characterized by a continuous fitting surface being provided at the top perimeter area of the outside surface of the box-shaped base block.

By means of the configuration of this sixth embodiment, the fitting surfaces continuous to the outside surface of the base block contact the inside surface of the case, thereby preventing the sealing agent from penetrating inside the base block. Operating problems caused by resin solidifying inside the base block are thus prevented, and yield is improved.

Furthermore, because the fitting surfaces are continuous to the outside surface of the base block, there is no variation in the adhesion strength, and a consistent seal can be obtained.

Moreover, because penetration of the sealing agent can be prevented by the fitting surfaces, the high dimensional accuracy required by the prior art in the gap between the outside surface of the bent terminals and the inside surface of the case is not required, and design and manufacture are simplified.

In addition, because the electromagnetic relay can be sealed by simply injecting and curing a sealing agent around the perimeter of the fitting surfaces, it is not necessary as it is in the prior art to fill the entire area where the base block and case are fit together with the sealing agent, and it is possible to reduce the amount of sealing agent required.

An electromagnetic relay according to a seventh embodiment of the invention is based on the sixth embodiment wherein the electromagnet block is postformed and integrally molded to the box-shaped base block.

The electrical insulation of the armature block is improved by means of this seventh embodiment because the electromagnet block is coated with a resin material and monolithically molded to the base block; and because the electromagnet block and base block are molded without gap therebetween into a monolithic body, the assembly precision is improved and mechanical strength is increased.

An electromagnetic relay according to an eighth embodiment of the invention is further characterized by the bottom part of the box-shaped base block projecting from the open side of the box-shaped case.

By means of this configuration, the side edge members near the bottom surface of the base block are exposed, making it possible to inject the sealing agent from a variable side position. The degree of freedom in sealing process operations is thereby increased, and production is thus facilitated.

Elastic deformation of the terminals is also improved because the length of the free end part of the terminals projecting from the opening in the case is longer than in the prior art. As a result, when an electromagnetic relay according to the present invention is surface mounted to a printed circuit board, repeated expansion and contraction of the circuit board due to heat can be absorbed by the elastic deformation of the terminals, thereby inhibiting separation of the terminals of the electromagnetic relay from the printed circuit board.

An electromagnetic relay according to a ninth embodiment of the invention is based on the eighth embodiment wherein an inclined face for guiding the sealing agent is provided in the side edge members near the bottom surface of the base block.

By means of this configuration, the inclined face for guiding the sealing agent provided in the side edge members near the bottom surface of the base block forms a positioning surface for use during sealing agent injection. Positioning of the nozzle used for sealing agent injection is thereby made even easier, and productivity is thus improved.

An electromagnetic relay according to a tenth embodiment of the invention is further characterized by the middle part of the terminals projecting from the box-shaped base block being bent to the outside and fit into the notched member formed in the lip of the opening in the box-shaped case, and the outside surface of the case being formed flush with the outside surface of the middle parts of the terminals.

By means of this configuration, the outside surface of the middle parts of the terminals and the outside surface of the case are flush, and a gap is formed between

the inside surface of the middle parts of the terminals and the outside surface of the base block, thus making positioning easier during sealing agent injection, and thereby further improving productivity.

According to the eleventh embodiment of the invention, an electromagnetic relay wherein the fixed contact terminals and coil terminals integrally formed to a roughly rectangular lead frame by stamping a single conductive sheet material are insertion molded to the base is characterized by the fixed contact terminals being formed in roughly an inverted "L" shape from one side of the lead frame toward roughly the center area of the adjoining edge; the coil terminals being formed in a U-shape through a connecting member from the center of said adjoining edge; and said connecting member being bent in the thickness direction, providing a step between the coil terminals and the fixed contact terminals.

By means of this eleventh embodiment, the coil terminals can move in the thickness direction without moving the free ends of the coil terminals to the outside because the connecting member of the coil terminals extending in a U-shape is bent in the thickness direction. A large step can thus be formed between the coil terminals and the fixed contact terminals, and the desired insulation distance can be assured.

According to the twelfth embodiment of the invention, an electromagnetic relay wherein the fixed contact terminals and coil terminals integrally formed to a roughly rectangular lead frame by stamping a single conductive sheet material are insertion molded to the base is characterized by the fixed contact terminals being formed in an inverted "L" shape from one side of the lead frame toward roughly the center area of the adjoining edge; the coil terminals being formed in a mirrored L-shape through a connecting member to the outside from the base of the fixed contact terminals; and said connecting member being bent in the thickness direction, providing a step between the coil terminals and the fixed contact terminals.

By means of this twelfth embodiment, the coil terminals can move in the thickness direction without moving the free ends of the coil terminals to the outside because the connecting member of the coil terminals extending in a mirrored L-shape is bent in the thickness direction. A large step can thus be formed between the coil terminals and the fixed contact terminals, and the desired insulation distance can be assured.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given below and the accompanying diagrams wherein:

Fig. 1 is a bird's-eye exploded view of an electromagnetic relay according to the preferred embodiment of the present invention;
Fig. 2 is a partial cross section of a plan view of the electromagnetic relay shown in Fig. 1;
Fig. 3 is a partial cross section of a front view of the electromagnetic relay shown in Fig. 1;
Fig. 4 is a partial cross section of a left side view of the electromagnetic relay shown in Fig. 1 used to describe the sealing process of the electromagnetic relay;
Fig. 5 is a bird's-eye view of the electromagnet block of an electromagnetic relay according to the present invention;
Fig. 6 is a cross section of the electromagnet block shown in Fig. 5 through line VI-VI therein;
Fig. 7 is a plan view of the electromagnet block shown in Fig. 5;
Fig. 8 is a front view of the electromagnet block shown in Fig. 5;
Fig. 9 is a bottom view of the electromagnet block shown in Fig. 5;
Fig. 10 is a left side view of the electromagnet block shown in Fig. 5;
Fig. 11 is a cross section of the electromagnet block shown in Fig. 8 through line XI-XI therein;
Fig. 12 is a cross section of the electromagnet block shown in Fig. 8 through line XII-XII therein;
Fig. 13 is a cross section of the electromagnet block shown in Fig. 7 through line XIII-XIII therein;
Fig. 14 is a cross section of the electromagnet block shown in Fig. 7 through line XIV-XIV therein;
Fig. 15 is a plan view of the lead frame used in the manufacture of an electromagnetic relay according to the present invention;
Fig. 16 is a plan view showing the lead frame in Fig. 15 after the bending process is accomplished;
Fig. 17 is a front view of the lead frame shown in Fig. 16 in the direction of arrow A in Fig. 16;
Fig. 18 is a right side view of the lead frame shown in Fig. 15 in the direction of arrow B in Fig. 15;
Fig. 19 is a plan view of the electromagnet block provided on the lead frame used in the manufacture of an electromagnetic relay according to the present invention;
Fig. 20 is a front view of the lead frame shown in Fig. 19 in the direction of arrow A in Fig. 19;
Fig. 21 is a left side view of the lead frame shown in Fig. 19 in the direction of arrow B in Fig. 19;
Fig. 22 is a cross section showing the postforming method used in the manufacture of an electromagnetic relay according to the present invention;
Fig. 23 is a cross section showing a postforming method different from the postforming method shown in Fig. 22;
Fig. 24 is a bird's-eye view of the base block formed by a postforming method according to the present invention;
Fig. 25 is a bird's-eye view of the base block formed by a postforming method according to the present invention after press-processing the base block;
Fig. 26 is a plan view of a lead frame according to another embodiment of an electromagnetic relay according to the present invention;

Fig. 27 is a front view of the lead frame shown in Fig. 26 in the direction of arrow A in Fig. 26;

Fig. 28 is an exploded bird's-eye view of an electromagnetic relay according to the prior art;

Fig. 29 is an overview used to describe the manufacturing method of the electromagnetic relay shown in Fig. 28;

Fig. 30 is an overview used to describe the manufacturing method of the electromagnetic relay shown in Fig. 28; and

Fig. 31 is a cross section used to describe the sealing method of the electromagnetic relay shown in Fig. 28.

DESCRIPTION OF PREFERRED EMBODIMENTS

The preferred embodiments of the present invention are described hereinbelow with reference to the accompanying Figs. 1 - 27. As shown in Figs. 1 - 25, the electromagnetic relays of the present invention comprise primarily an electromagnet block 10, a base block 20 formed by postforming the electromagnet block 10, a permanent magnet 30, an armature block 40, and a case 50.

As shown in Figs. 5 and 6, the electromagnet block 10 is formed by winding a coil 16 around a spool 12 formed by insertion molding a C-shaped core 11. Note that for ease of illustration, the coil 16 is not shown in Fig. 5.

As shown in Fig. 5, the core 11 is provided at both ends thereof with pole faces 11a and 11b which are exposed above the top surface of the collars 13 and 14 formed on the ends of the spool 12. One set of relay terminals 17 and 18 is insertion molded to each of the collars 13 and 14, and binding members 17a and 18a project from the sides of the collars 13 and 14. A guide channel 13a is also formed in the side edge of the collar 13; one end of this guide channel 13a is positioned near the base of the binding member 17a as shown in Fig. 11, and the other end is provided at the inside surface of the collar 13 near the outside surface of a first waist member 12a. Another guide channel 14a similar to this guide channel 13a is also formed in the other collar 14 (see Fig. 8).

As shown in Figs. 7, 8, and 10, the relay terminals 17 and 18 each comprise an anchor member 17b and 18b, respectively, insertion molded deep in the respective collar 13 and 14 in a manner preventing extraction of the anchor member.

An insertion hole 15a for inserting the permanent magnet 30, described later below, is formed in the center collar 15 provided at a position offset from the lengthwise center of the spool 12, and parallel guide channels 15b and 15c are provided with the insertion hole 15a therebetween. The bottom of the guide channel 15b is flat as shown in Fig. 13 with both ends positioned near the outside surface of the first and second waist members 12a and 12b. The bottom of the other guide channel 15c is inclined as shown in Fig. 14 with one end positioned near the outside surface of the first waist member 12a, and the other end provided at a position elevated slightly above the outside surface of the second waist member 12b. The ends of the guide channels 15b and 15c on the side toward the first waist member 12a are provided substantially equidistant from the outside surface of the first waist member 12a. It is to be further noted that the shapes of the guide channels 15b and 15c shall not be limited to that described above, and the angle of inclination, specific positions, and other parameters may be designed appropriately according to the number of winds in the coil.

Therefore, as shown in Figs. 7 - 11, after winding one end of the coil 16 to the binding member 17a of the relay terminal 17 insertion molded to the collar 13, the coil 16 is pulled along the guide channel 13a in the collar 13 to the first waist member 12a in the spool 12, and wound to approximately 20% of the desired number of winds. The coil 16 is then pulled through the guide channel 15b in the center collar 15 to the second waist member 12b, and wound to 100% of the desired number of winds. The coil 16 is then pulled back through the inclined guide channel 15c in the center collar 15 to the first waist member 12a, and wound the remaining 80% of the desired number of winds. After then winding the coil 16 to the binding member 18a of the other relay terminal 18, the coil 16 is soldered to both binding members 17a and 18a to complete the coil winding process.

By means of this embodiment, because the number of winds to the first waist member 12a accomplished in the first winding operation of the coil 16 is only about 20% of the total, and the remaining 80% is then wound during the second winding operation, the final end wind of the coil 16 is separated by a predetermined distance from the end of the first wind of the coil 16 to the first waist member 12a. As a result, even if the insulation coating of the coil 16 at the final outside surface of the coil is slightly melted and removed by the heat of the resin material during the postforming process described below, the voltage difference between the coil 16 at the outside surface and the coil 16 directly therebelow is small; resistance to shorting is thereby improved, and production yield is improved.

It is to be noted that while the coil is first wound to approximately 20% of the total winds to the first waist member 12a, is then wound to 100% of the winds to the second waist member 12b, and is then wound the remaining 80% to the first waist member 12a, the invention shall not be so limited. It is also possible, for example, to first wind the coil to approximately 50% of the total winds to the first waist member 12a.

The base block 20 is formed by integrating the electromagnet block 10 and the lead frame 60 in a postforming process. As shown in Figs. 15 - 18, this lead frame 60 is formed by bonding fixed contacts 23a and 24a to a predetermined position in the hoop material; stamping to form on the inside of the roughly rectangular frame the coil terminals 21, common terminals 22, part of the fixed contact terminals 23 and 24, and the connector tabs 62;

cutting away the shaded areas shown in Fig. 15; and then bending the coil terminals 21 in the thickness direction of the sheet (see Figs. 16 - 18).

Note in particular that a pair of connector tabs 62 project from roughly the center of opposing sides 60a and 60b of the lead frame 60, and the coil terminals 21 form a basic U-shape from the base of the connector tabs 62 through the connecting member 61.

The lead frame 60 further comprises connecting members 63 at approximately the middle of the sides 60c and 60d adjoining the sides 60a and 60b on which the connector tabs 62 are provided. The common terminals 22 comprising a T-shaped connector receiver 22a on the free end thereof are provided from approximately the center of the connecting members 63.

The fixed contact terminals 23 and 24 extend from the connecting members 63 on opposite sides of the common terminals 22, and respectively comprise fixed contacts 23a and 24a roughly perpendicular to the fixed contact terminals 23 and 24 on the free ends thereof.

As shown in Figs. 19 - 21, the lead frame 60 is then turned over, and the relay terminals 17 and 18 of the electromagnet block 10 are then positioned on the free ends of the coil terminals 21 and connected integrally thereto by laser welding.

Next, as shown in Fig. 22, the integral assembly of the electromagnet block 10 and the lead frame 60 is assembled into the bottom mold 70. The top mold 73 is then fit to the bottom mold 70, and the corner of the core 11 is engaged by the positioning members 74 of the top mold 73, thereby fitting the insertion hole 15a in the electromagnet block 10 to the positioning pin 71 in the bottom mold 70 and pressing the pole faces 11a and 11b of the core 11 against the support pins 72 to complete the initial positioning.

The molten resin material is then injected from the gate 76 of the runner 75 provided in the top mold 73 to the injection hole 15d in the electromagnet block 10. The pressure of the injected resin pushes and strongly positions the electromagnet block 10 against the bottom mold 70, and the resin material overflow from the injection hole 15d fills the cavity 77 to form the base block 20. The bottom mold 70 is then lowered to demold the molded base block 20 from the top mold 73, and the support pins 72 are used to eject the core 11 and thus demold the completed base block 20 from the bottom mold 70 (see Fig. 24). Note that a continuous fitting surface 25 (the shaded area in Fig. 1) is formed around the top outside edge member of the base block 20, and an inclined face 26 for guiding the sealing agent is provided in the outside edge members near the bottom of the base block.

One benefit of the present embodiment thus comprised is the high dimensional accuracy obtained by providing the positioning pin 71 substantially coaxially to the gate 76, and preventing deformation of the core 11 in the thickness direction by the resin pressure. This deformation in the thickness direction can be effectively prevented even if, for example, the electromagnet block 10 comprises a U-shaped core 11 measuring approximately 2 mm wide, 2 mm thick, and 15 mm long, and high dimensional accuracy can thus be assured.

In the above embodiment the electromagnet block 10 is initially positioned to the bottom mold 70 by the positioning members 74 provided in the top mold 73, and is then firmly positioned by the resin pressure of the resin material injected from the runner gate 76, but the invention shall not be so limited. As shown in Fig. 23, for example, additional runners 78 with gates 79 may be provided in the top mold 73, and the resin material injected from each of the gates 76 and 79. In this case, too, the resin pressure of the injected resin material will press and firmly position the electromagnet block 10 against the bottom mold 70.

The coil terminals 21 are also described as extending from sides different from those from which the fixed contact terminals 23 and 24 extend in the above embodiment, but the invention shall not be so limited. As shown in Fig. 26 and Fig. 27, for example, the coil terminals 21 may be extended from the connecting members 63 of the fixed contact terminals 23 and 24 to the outside in an "L" shape through the connecting members 61, and the connecting members 61 then bend in the thickness direction to provide a step between the fixed contact terminals 23 and 24 and the coil terminals 21.

As shown in Fig. 25, a press process is next applied to the lead frame 60, now integrally connected with the base block 20 by the preceding postforming process, severing the coil terminals 21 from the connecting members 61, severing the common terminals 22 and fixed contact terminals 23 and 24 from the connecting members 63, bending the free ends of the terminals down, and then bending the terminals down from the bases thereof to complete the base block 20.

By means of this embodiment, because the connector tabs 62 of the lead frame 60 are embedded in the outside surface of the base block 20 by insertion molding, the base block 20 does not fall away from the lead frame 60 when the terminals 22, 23, and 24 are severed from the lead frame 60, and the base block 20 can therefore be transported while integrally supported by the lead frame 60.

Furthermore, because the anchoring tabs 22b (see Figs. 16 - 18) extending axially from the T-shaped connector receivers 22a of the common terminals 22 are insertion molded to the open edge of the base block 20, the connector receivers 22a of the common terminals 22 will not come loose even after the common terminals 22 projecting from the outside surface of the base block 20 are bent from the terminal base.

The above embodiment is also described with the ends of the terminals 21, 22, 23, and 24 pre-bent to the inside, but the invention shall not be so limited. It is also possible, for example, to pre-bend the ends of the terminals 21, 22, 23, and 24 to the outside, or to first fit the case 50 to the base block 20, seal the case and base block with the sealing agent 80, tack the terminals, and then bend the terminals to the inside or outside.

It is to be noted that the advantage of bending the ends of the terminals to the inside is a smaller device footprint and resulting higher mounting density. The advantage of bending the ends of the terminals to the outside is easier soldering and improved adhesion reliability.

The permanent magnet 30 is basically a rectangularprism-shaped sintered body of rare earth materials, and is inserted from above to the insertion hole 15a of the electromagnet block 10 supported by the lead frame 60 until the pole face 31 on the bottom of the permanent magnet 30 contacts the top of the core 11. The permanent magnet 30 is then polarized.

As shown in Fig. 1, the armature block 40 comprises movable contactors 42 provided on both sides of the armature 41 and molded together by the support member 43.

The armature 41 is a flat, rectangular member made from a magnetic material with support pads 41c formed by extrusion at the middle of the bottom surface (see Fig. 3).

The movable contactors 42 each comprise twin contacts on each end by dividing the width of the movable contactors 42 into two parts to form movable contacts 42a and 42b. Flat T-shaped connectors 42c also extend to the sides from the middle of the movable contactors 42, and project from the side of the support member 43.

The support member 43 is a resin molding integrating the armature 41 and movable contactors 42 by insertion molding. The support pads 41c for the armature 41 are exposed from the middle bottom of the support member 43.

Therefore, the armature block 40 is assembled from above to the base block 20 supported by the lead frame 60; the support pads 41c of the armature 41 are placed on the pole face 32 of the permanent magnet 30; and the connectors 42c are positioned to the connector receiver 22a of the common terminals 22 and laser welded. As a result, the ends 41a and 41b of the armature 41 alternately contact and separate from the pole faces 11a and 11b of the core 11, and the movable contacts 42a and 42b alternately contact and separate from the fixed contacts 23a and 24a.

It is to be noted that because the support pads 41c of the armature 41 are positioned offset from the center of the pole face 32 of the permanent magnet 30, the magnetic balance between the right and left ends is disrupted, creating an automatic reset type electromagnetic relay.

The case 50 is a box-shaped resin molding for fitting to the armature block - base block subassembly. Notches 51, 51, 52, 53, and 54 are provided in the open edge of the case 50 for fitting to the coil terminals 21 and 21, common terminals 22, and fixed contact terminals 23 and 24, respectively. A gas bleeder hole 55 is provided in a top corner of the case 50.

When the case 50 is partially fit to the base block 20 supported by the lead frame 60 and then pressed down, the base block 20 is separated from the connector tabs 62 of the lead frame 60. When the case 50 is pressed further down, the case 50 is fit completely to the base block 20, and the notches 51 - 54 in the case 50 are fit over the middle of the terminals 21 - 24 with the outside surface of the middle of the terminals 21 - 24 flush with the outside surface of the case 50.

Because the height of the case 50 is less than the height of the base block 20, the bottom of the base block 20 is exposed from the open side of the case 50 as shown in Fig. 4, and the inclined face 26 provided in the outside edge members near the bottom of the base block 20 is exposed.

As a result of the present embodiment not cutting the connector tabs 62, the present embodiment provides the further benefit of no chips or other cutting residue being introduced to the base block 20.

It is to be noted that the above embodiment is described as separating the base block 20 from the connector tabs 62 by forcing the base block 20 to drop away from the connector tabs 62, but the invention shall not be so limited. It is also possible, for example, to embed the connector tabs 62 deep in the base block 20 by insertion molding, and then cut the connector tabs 62 to separate the base block 20 from the lead frame 60.

When the sealing agent 80 is then injected in the direction of the inclined face 26 provided in the outside edge members near the bottom of the base block 20, the sealing agent 80 follows this inclined face 26 to seal the gap between the base block 20 and the case 50. The continuous fitting surface 25 provided on the outside surface of the base block 20, however, contacts the inside corner edges of the case 50, thereby preventing penetration of the sealing agent 80 into the base block 20.

Assembly is completed by removing any internal gas from the gas bleeder hole 55 in the case 50, and then heat sealing the hole 55.

The operation of an electromagnetic relay comprised as described above is described below with reference to Figs. 1 - 3.

First, the side-side magnetic balance of the relay is unbalanced when the relay is unexcited, causing the one end 41a of the armature 41 to be attracted to the corresponding pole face 11a of the core 11, the one movable contact 42a of the movable contactors 42 to contact the corresponding fixed contacts 23a, and the other movable contact 42b to separate from the corresponding fixed contact 24a.

When a voltage is then applied to the coil 16, creating a magnetic flux cancelling the magnetic force of the permanent magnet 30 and exciting the electromagnet block 10, the armature 41 is rocked on the support pads 41c against the magnetic force of the permanent magnet 30, and the one end 41a of the armature 41 separates from the corresponding pole face 11a of the core 11. The movable contacts 42a next separate from the fixed contacts 23a, the other movable contacts 42b contact the fixed contacts 24a, and the other end 41b of the armature 41 is attracted to the pole face 11b of the core 11.

When the voltage supply is then interrupted to cancel excitation of the coil 16, the magnetic imbalance is restored. The magnetic force of the permanent magnet 30 thus reverses the above operation of the armature 41, and the armature block 40 rocks back to the original unexcited state.

It is to be noted that the above embodiment is described using an electromagnetic relay formed by postprocessing the electromagnet block, but the invention shall not be so limited. It will be obvious that the invention can also be applied to electromagnetic relays made by first monolithically molding the base block to the lead frame, and then installing the electromagnet block and other internal component parts.

FIELD OF APPLICATION IN INDUSTRY

It will further be obvious that the manufacturing method for an electromagnetic relay according to the present invention can be applied to other devices. For example, the postforming of the spool may be adapted to switches and other electrical switching devices, and to postforming of other electromagnetic apparatus.

Claims

1. A manufacturing method for an electromagnetic relay comprising:

   a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material;

   a process for monolithically molding the base block to the terminals and connector tabs of this lead frame;

   a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and

   a process for then causing the base block to fall from the connector tabs of the lead frame to separate the base block from the lead frame.

2. A manufacturing method for an electromagnetic relay comprising:

   a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material;

   a process for positioning and then connecting an electromagnet block to a specified terminal of the lead frame;

   a process for postforming the electromagnet block and monolithically molding the base block to the terminals and connector tabs;

   a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and

   a process for then causing the base block to fall from the connector tabs of the lead frame to separate the base block from the lead frame.

3. A manufacturing method for an electromagnetic relay comprising:

   a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material;

   a process for monolithically molding the base block to the terminals and connector tabs of this lead frame;

   a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and

   a process for then severing the connector tabs of the lead frame to separate the base block from the lead frame.

4. A manufacturing method for an electromagnetic relay comprising:

   a process for forming a lead frame comprising a plurality of terminals and at least one set of connector tabs by stamping a hoop material;

   a process for positioning and then connecting an electromagnet block to a specified terminal of the lead frame;

   a process for postforming the electromagnet block and monolithically molding the base block to the terminals and connector tabs;

   a process for assembling the internal component parts to the base block after severing the terminals from the lead frame and then bending the terminals; and

   a process for then severing the connector tabs of the lead frame to separate the base block from the lead frame.

5. A manufacturing method for an electromagnetic relay comprising:

   a process for placing inside the cavity of the mold a spool wrapped with a coil; and

   directly injecting resin from the gate of the mold directly into at least one of the positioning holes provided in said spool to fill said cavity with the resin material.

6. An electromagnetic relay wherein:

   the terminals projecting from the top perimeter area of the outside surface of the box-shaped base block housing the electromagnet block are bent downward from the terminal base; and

   a sealing agent is injected to and cured in to seal the space formed between the box-shaped base block and the box-shaped case fit to the box-shaped base block;

   is characterized by:

   a continuous fitting surface being provided at

the top perimeter area of the outside surface of the box-shaped base block.

7. An electromagnetic relay according to Claim 6 characterized by:

the electromagnet block being postformed and formed integrally to the box-shaped base block.

8. An electromagnetic relay wherein:

the terminals projecting from the top perimeter area of the outside surface of the box-shaped base block housing the electromagnet block are bent downward from the terminal base; and

a sealing agent is injected to and cured in to seal the space formed between the box-shaped base block and the box-shaped case fit to the box-shaped base block;

is characterized by:

the bottom part of the box-shaped base block projecting from the open side of the box-shaped case.

9. An electromagnetic relay according to Claim 8 characterized by:

an inclined face for guiding the sealing agent provided in the side edge members near the bottom surface of the base block.

10. An electromagnetic relay wherein:

the terminals projecting from the top perimeter area of the outside surface of the box-shaped base block housing the electromagnet block are bent downward from the terminal base; and

a sealing agent is injected to and cured in to seal the space formed between the box-shaped base block and the box-shaped case fit to the box-shaped base block;

is characterized by:

the middle part of the terminals projecting from the box-shaped base block being bent to the outside and fit into the notched member formed in the lip of the opening in the box-shaped case; and

the outside surface of the case being formed flush with the outside surface of the middle parts of the terminals.

11. An electromagnetic relay wherein:

the fixed contact terminals and coil terminals integrally formed to a roughly rectangular lead frame by stamping a single conductive sheet material are insertion molded to the base;

is characterized by:

the fixed contact terminals being formed in roughly an inverted "L" shape from one side of the lead frame toward roughly the center area of the adjoining edge;

the coil terminals being formed in a U-shape through a connecting member from the center of said adjoining edge; and

said connecting member being bent in the thickness direction, providing a step between the coil terminals and the fixed contact terminals.

12. An electromagnetic relay wherein:

the fixed contact terminals and coil terminals integrally formed to a roughly rectangular lead frame by stamping a single conductive sheet material are insertion molded to the base;

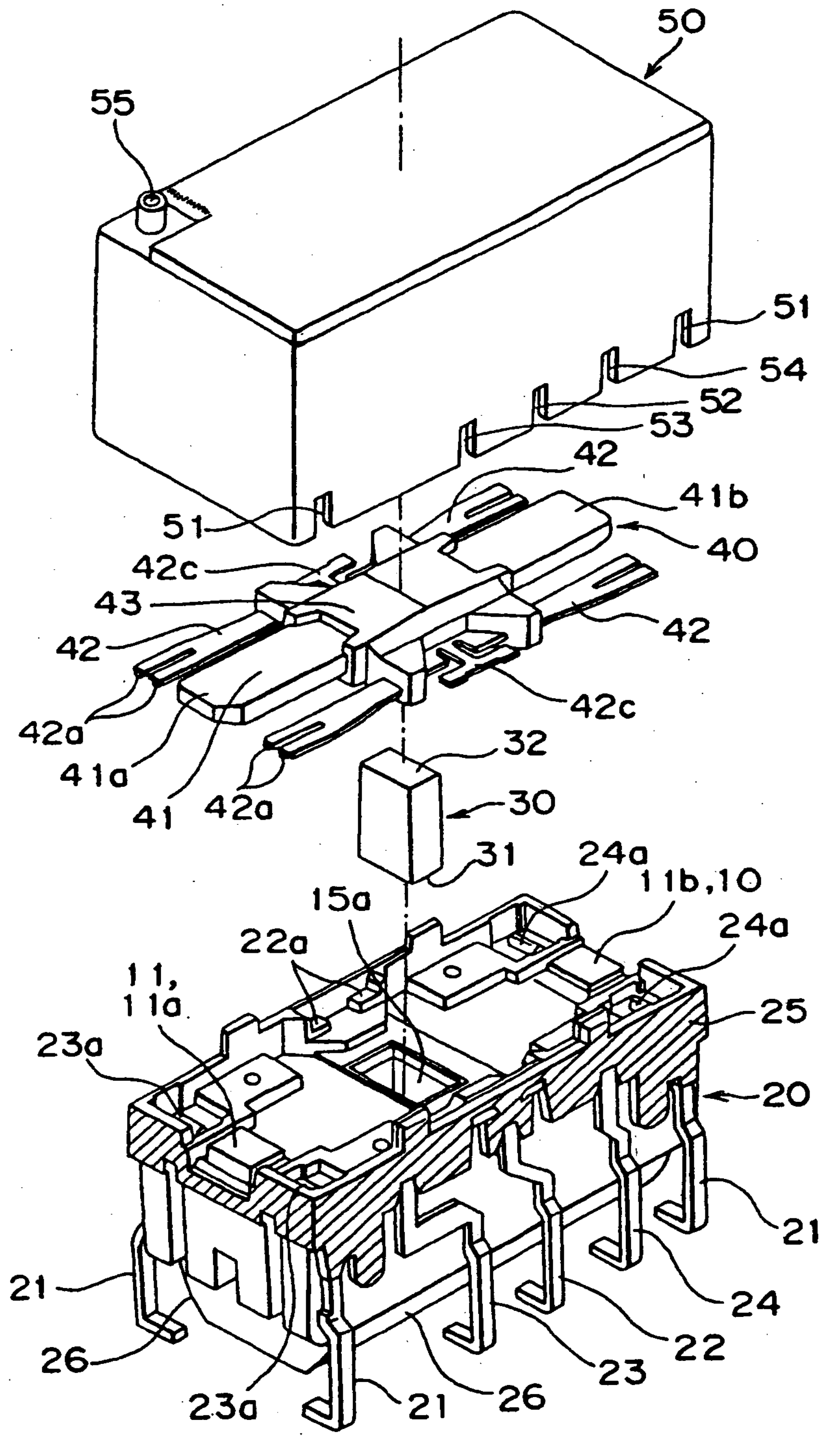
is characterized by:

the fixed contact terminals being formed in an inverted "L" shape from one side of the lead frame toward roughly the center area of the adjoining edge;

the coil terminals being formed in a mirrored L-shape through a connecting member to the outside from the base of the fixed contact terminals; and

said connecting member being bent in the thickness direction, providing a step between the coil terminals and the fixed contact terminals.

Fig. 1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30
31
24a
11b,10
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11,
11a
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23a
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21
26
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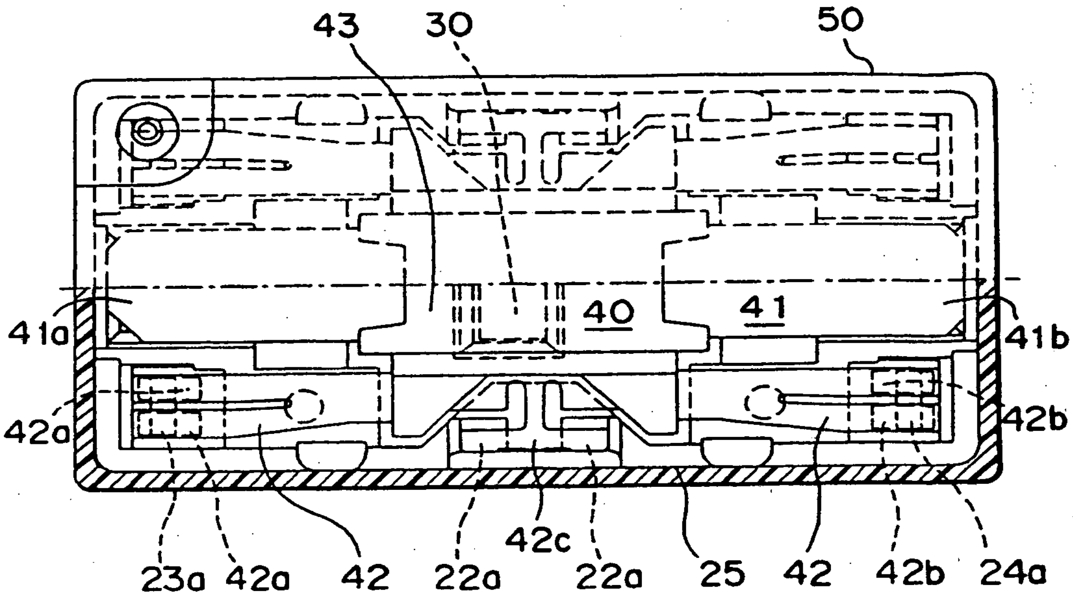
22
23
23a
21
26

Fig. 2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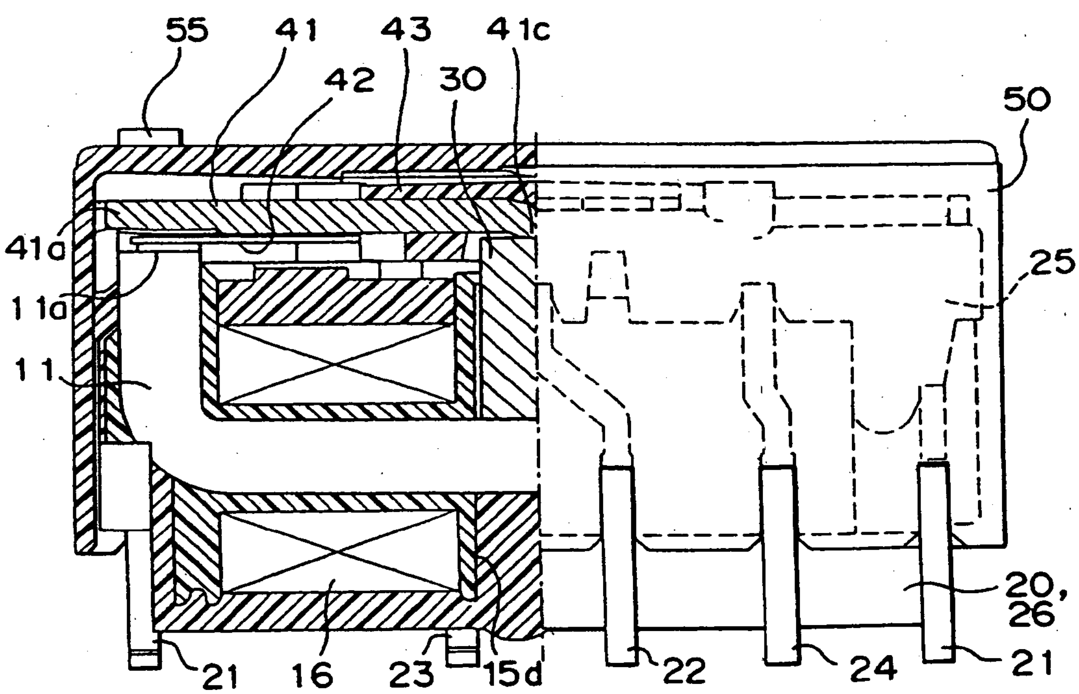
42b
24a

Fig. 3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24
21

Fig. 4

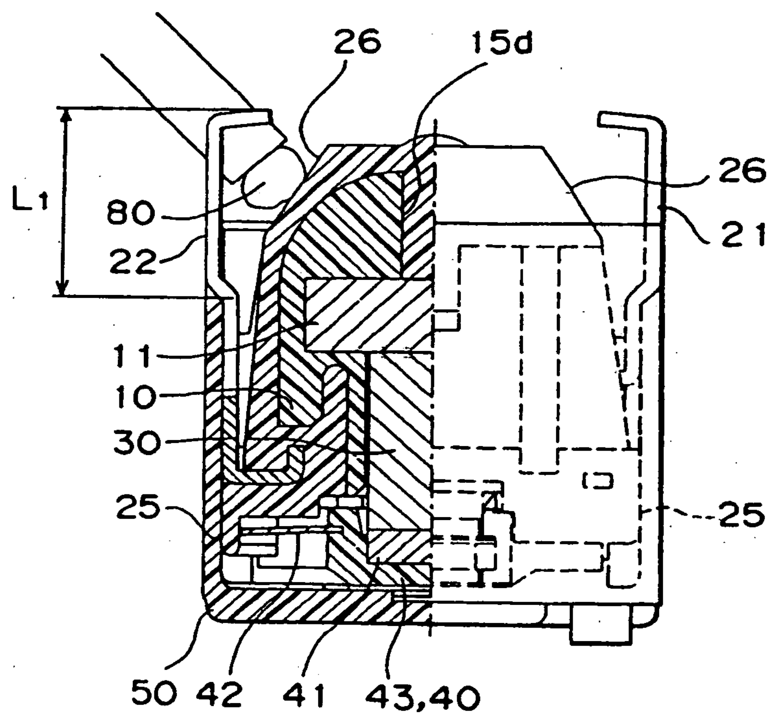
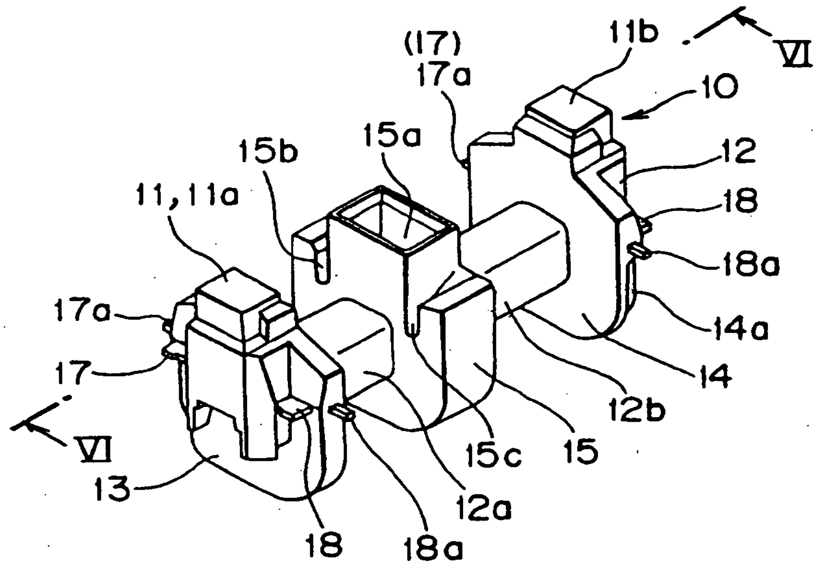


Fig. 5


(17)
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VI
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15b
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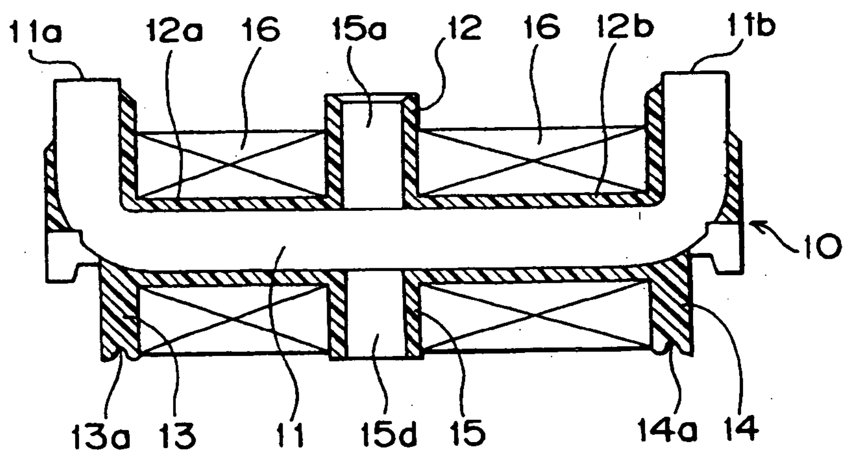
12b
VI
15c
15
13
12a
18
18a

Fig. 6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13
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15d
15
14a
14

Fig. 7

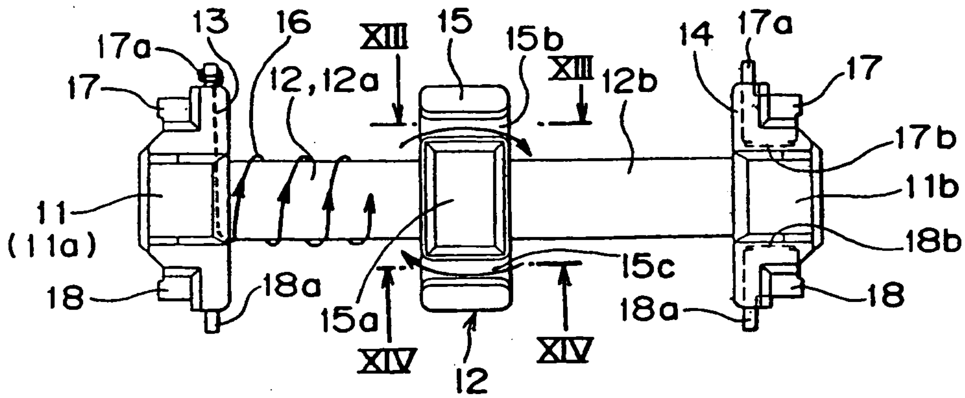


Fig. 8

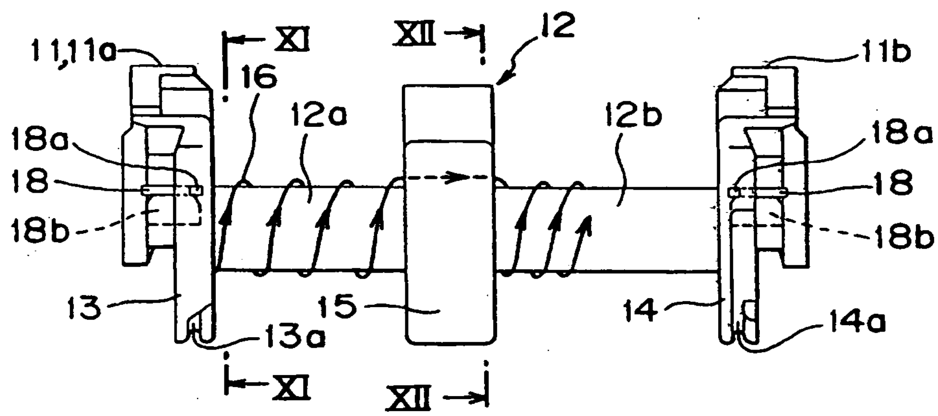


Fig. 9

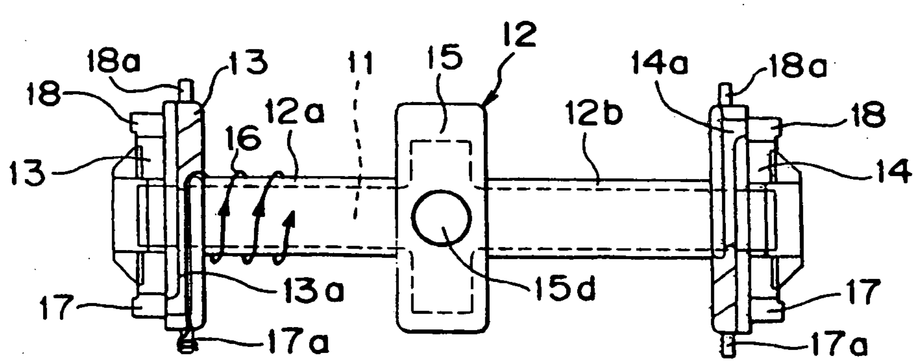
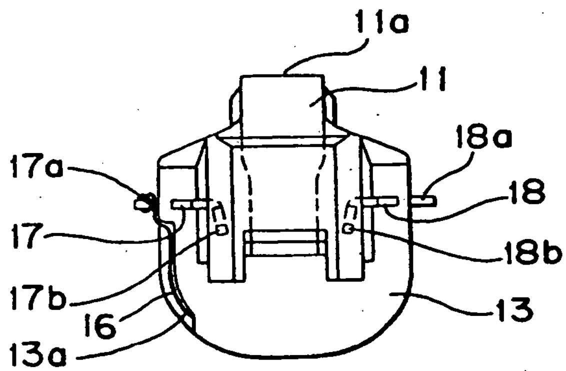


Fig. 10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17b
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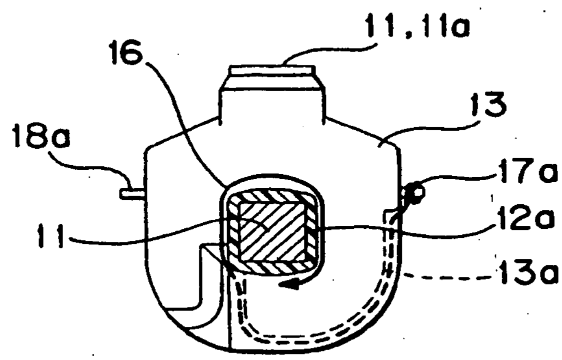
13a

Fig. 11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18a
17a
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12a
13a

Fig. 12

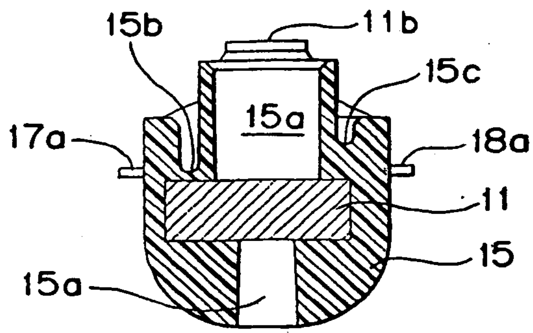


Fig. 13

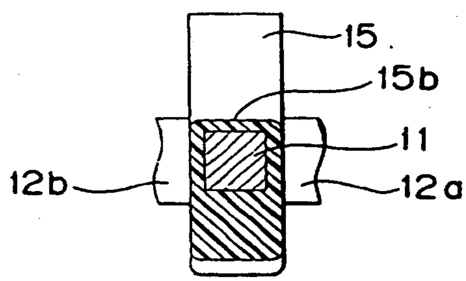


Fig. 14

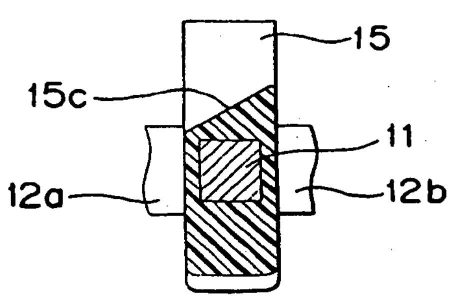
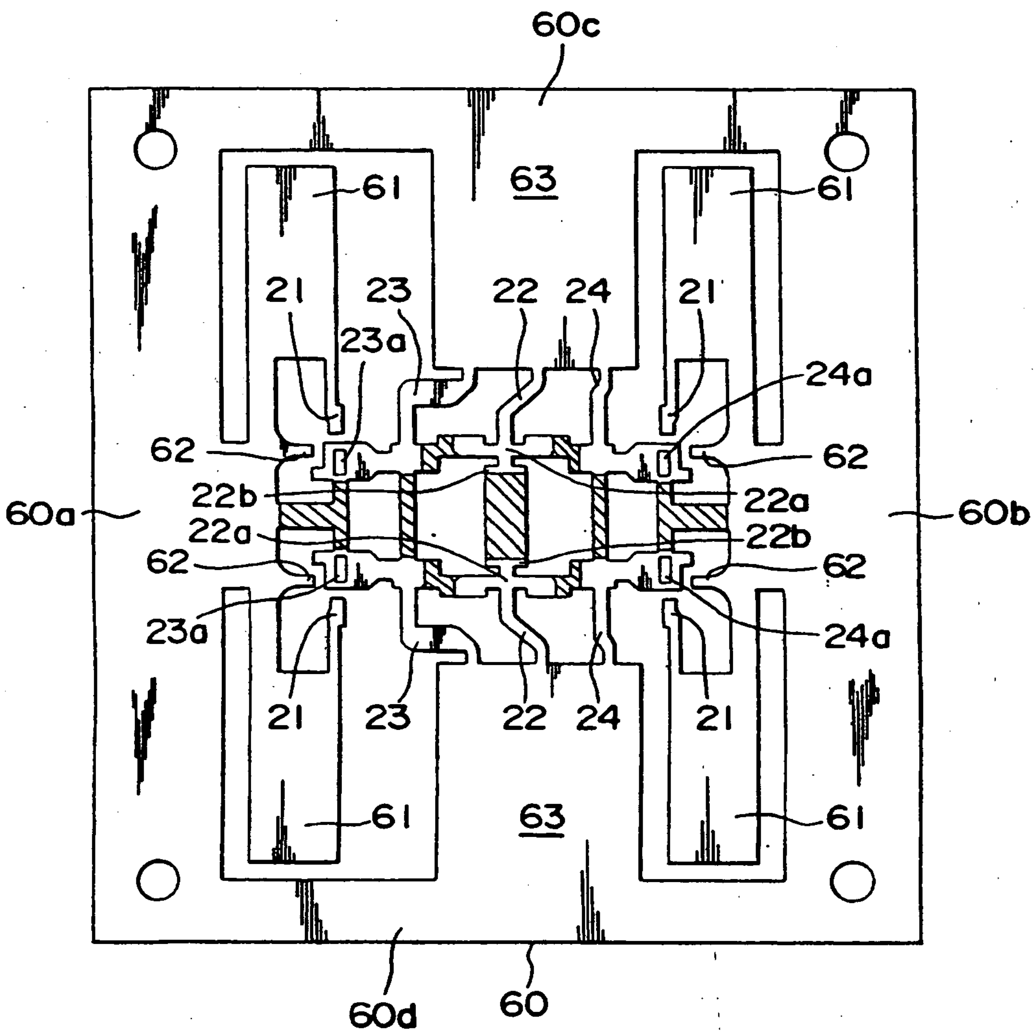


Fig. 15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60d
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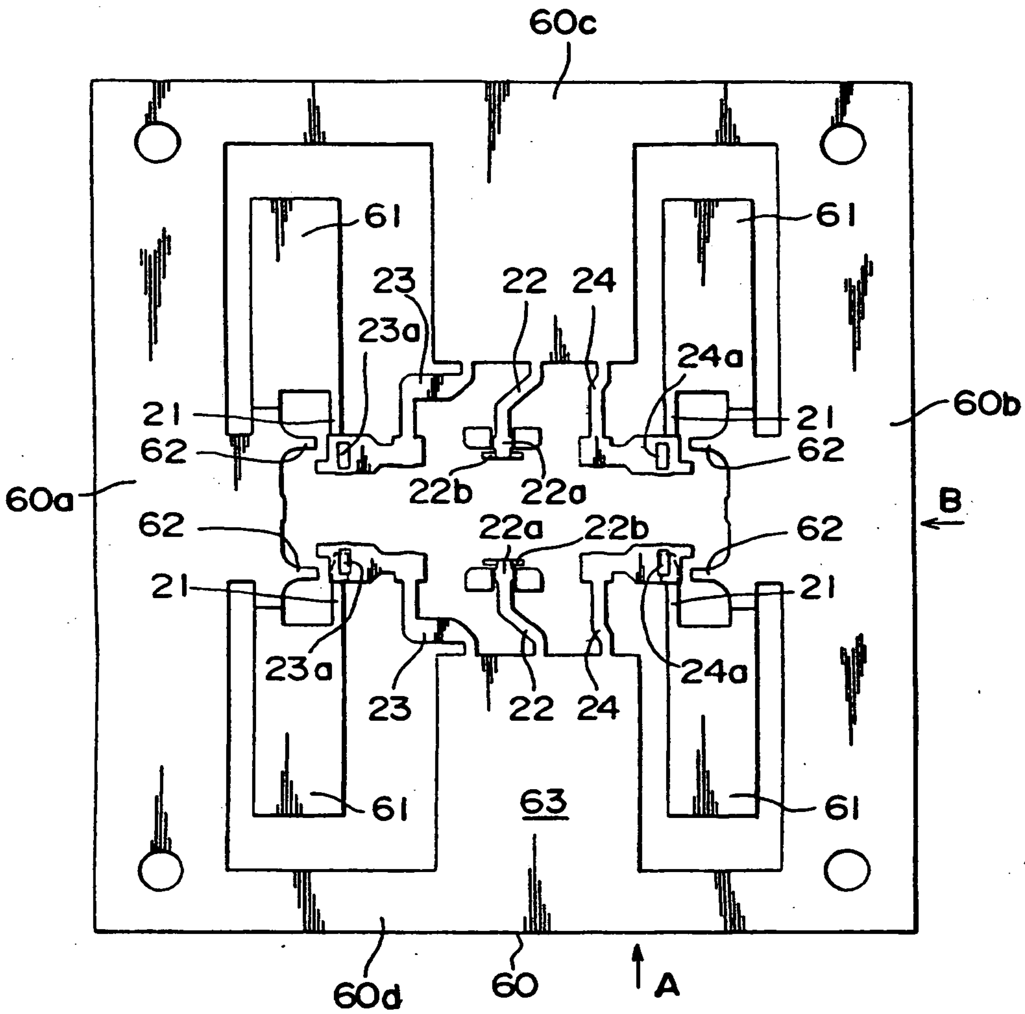
Fig. 16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60d
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A

Fig. 17

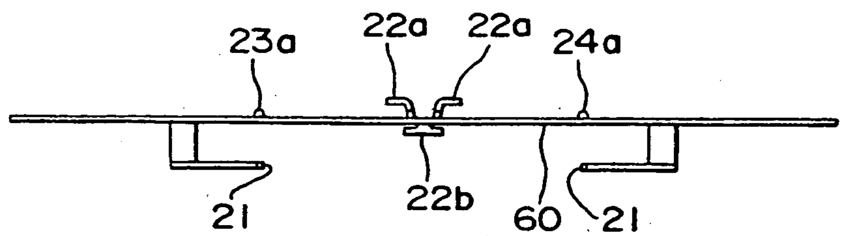


Fig. 18

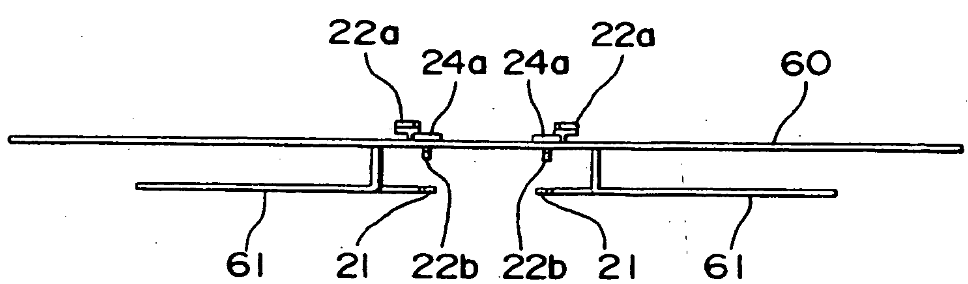
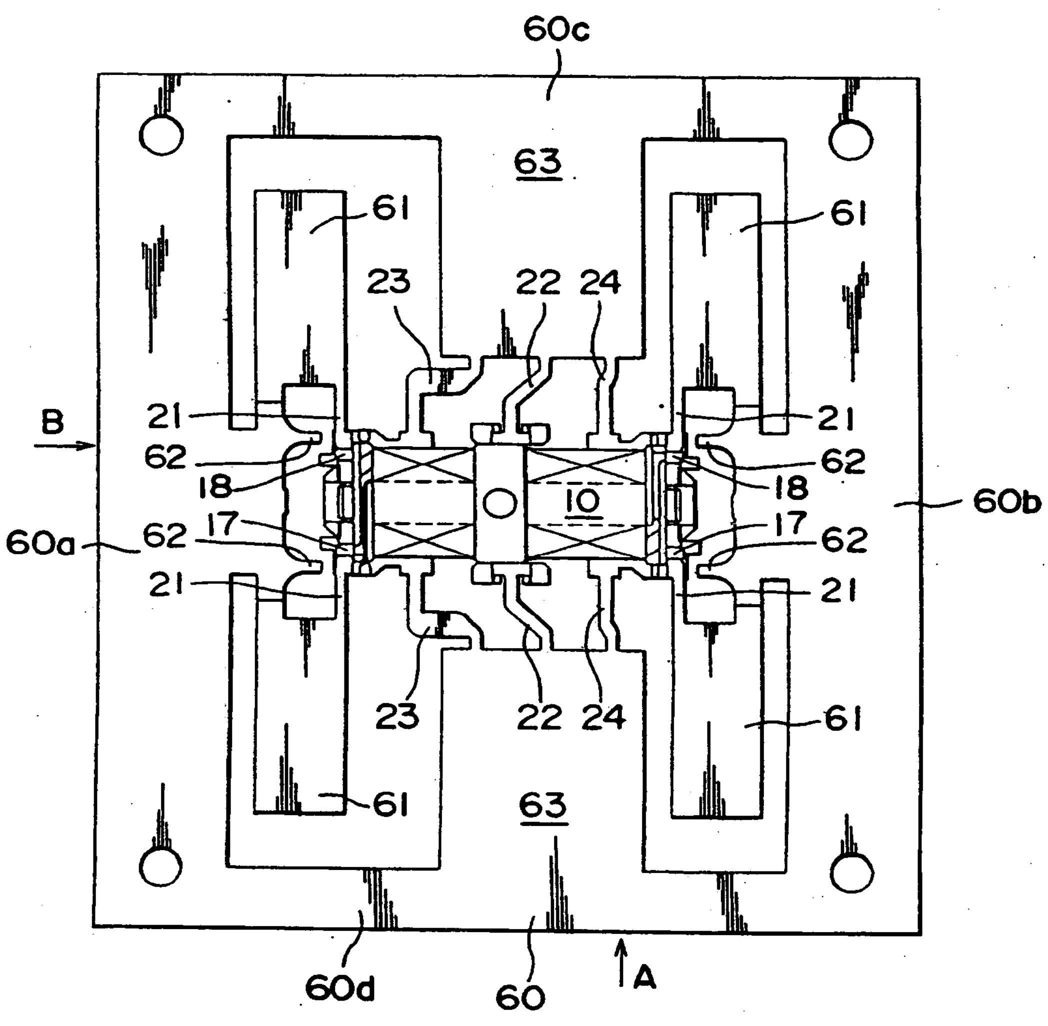


Fig.19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A

Fig. 20

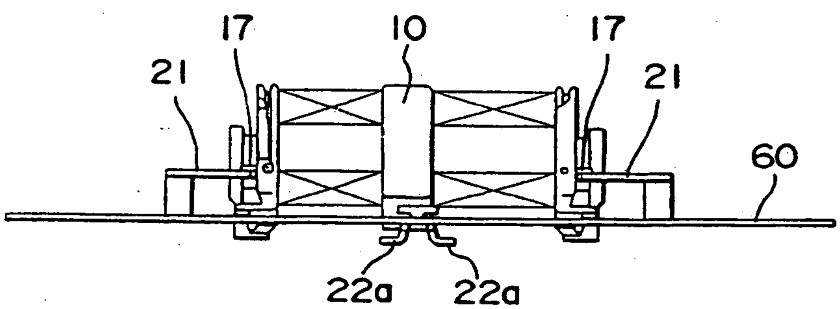

Fig. 21

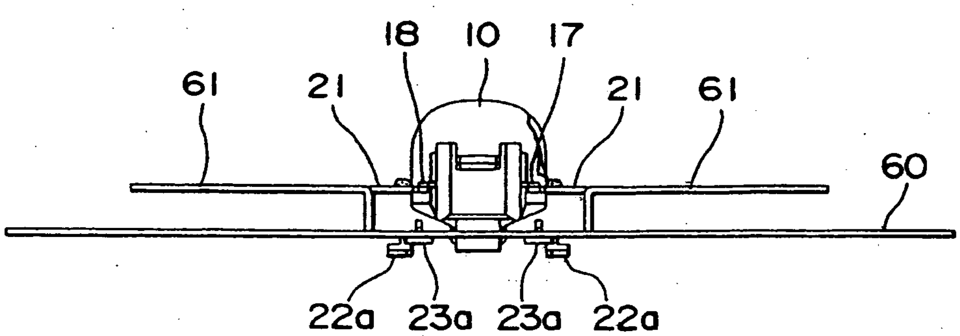

Fig.22

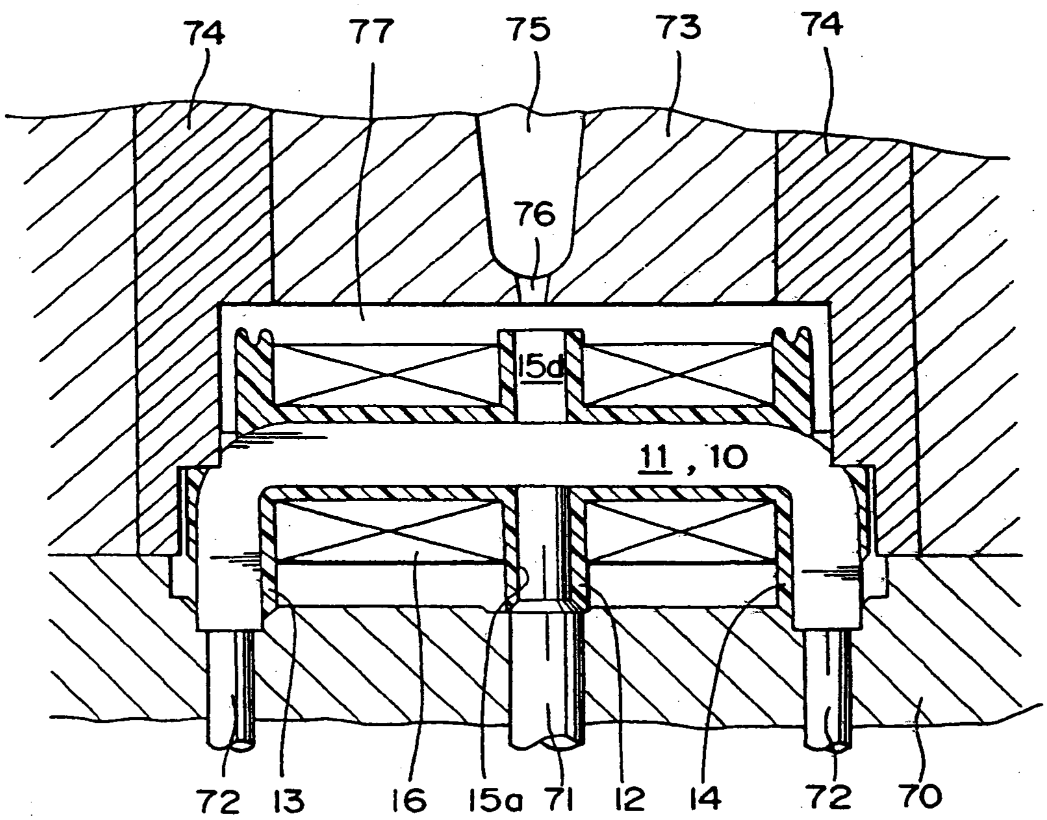

Fig. 23

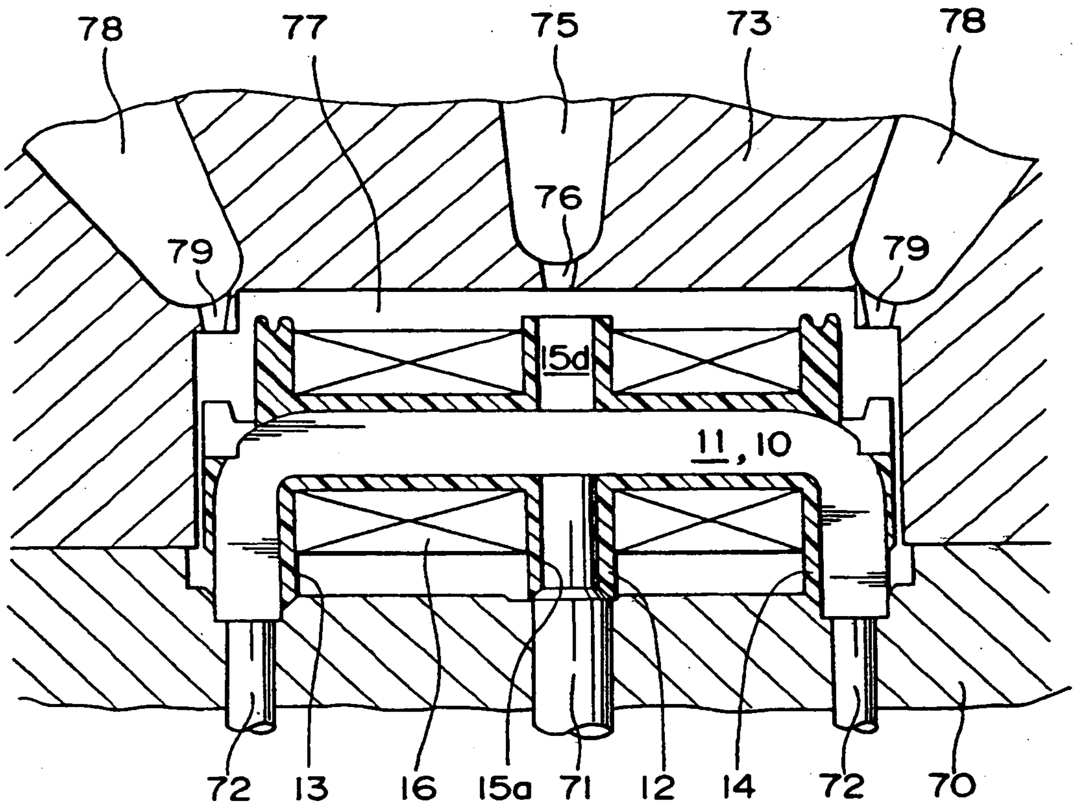

Fig. 24

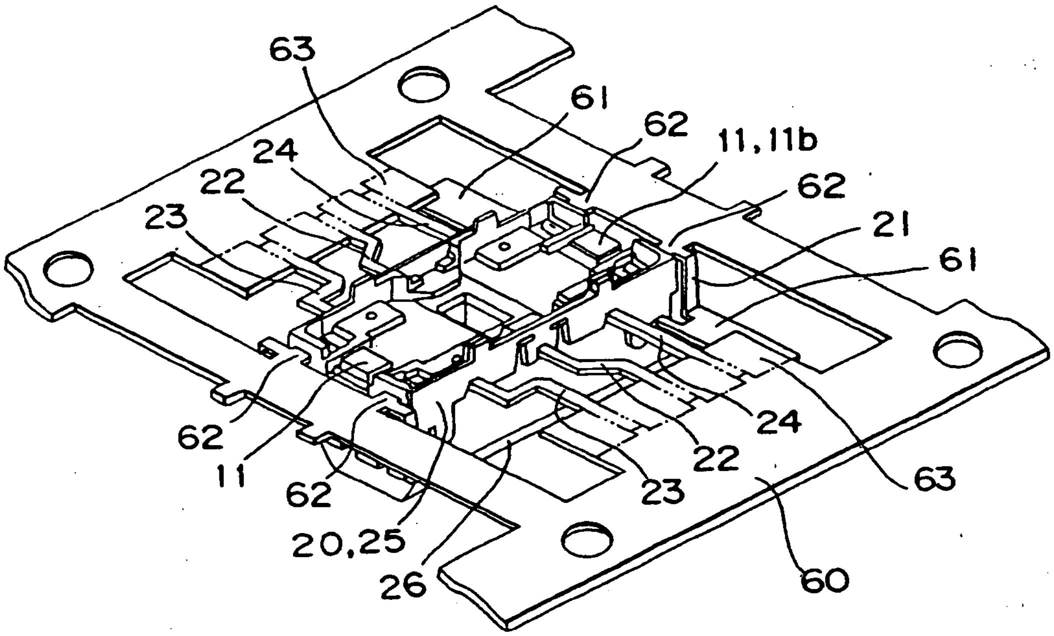
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Fig. 25

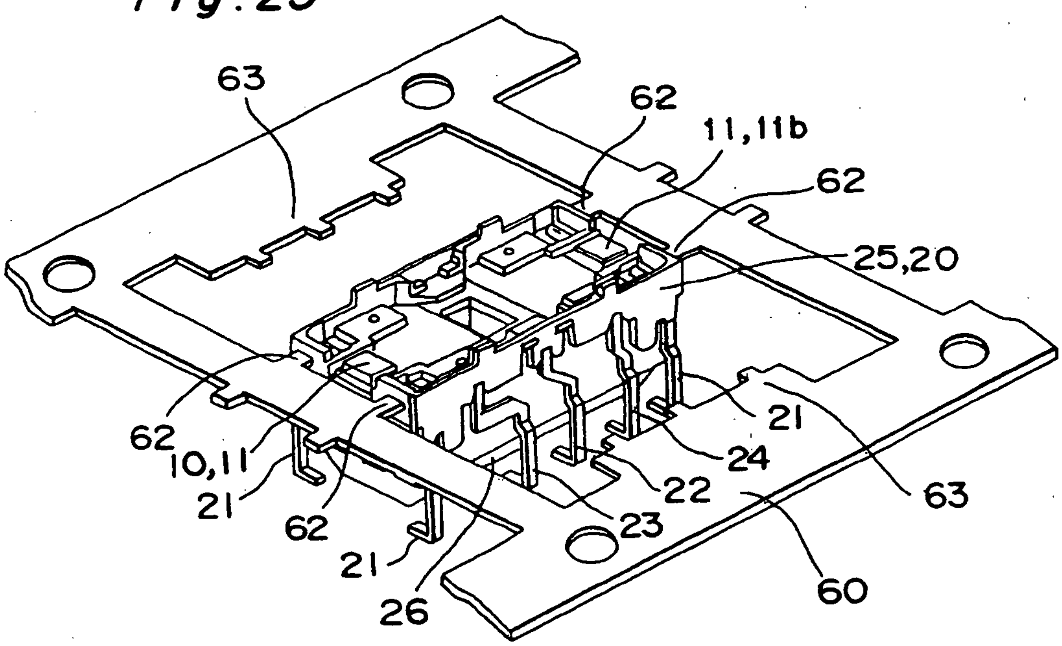
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Fig. 26

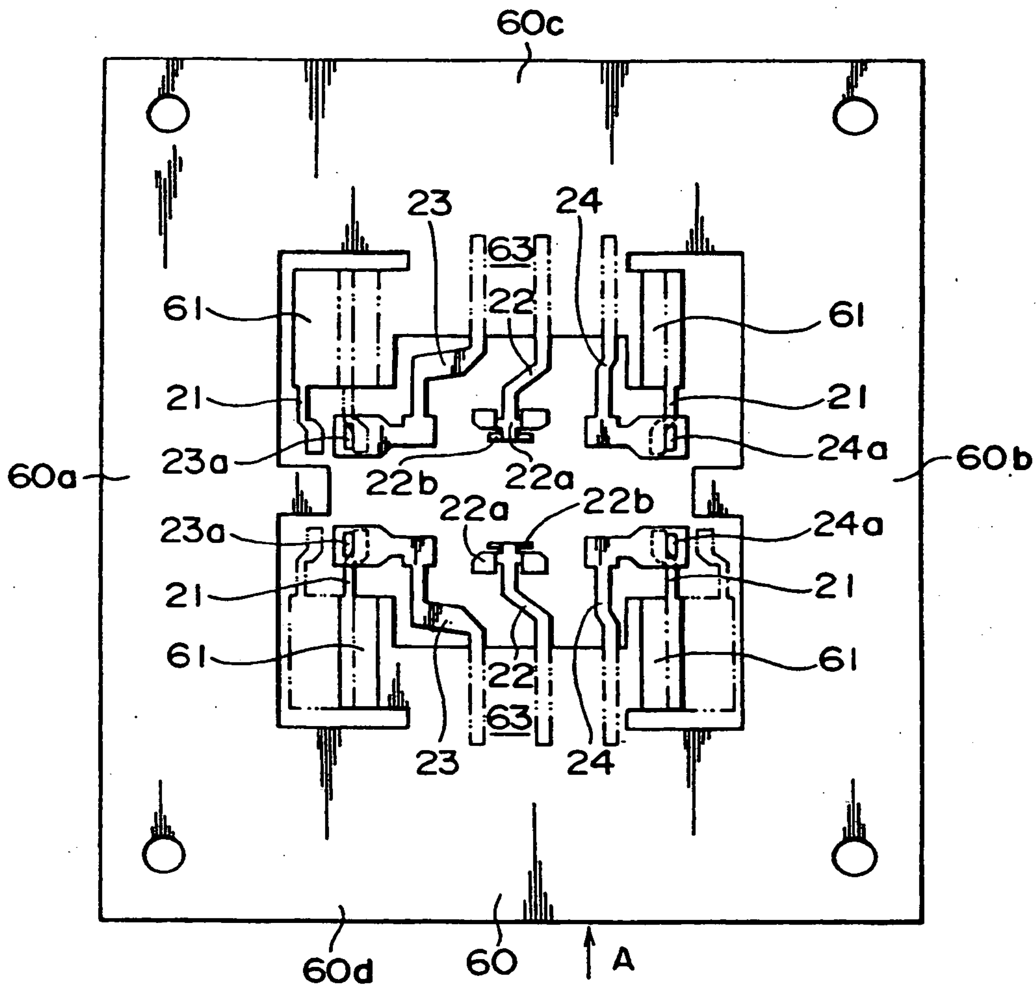
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Fig. 27

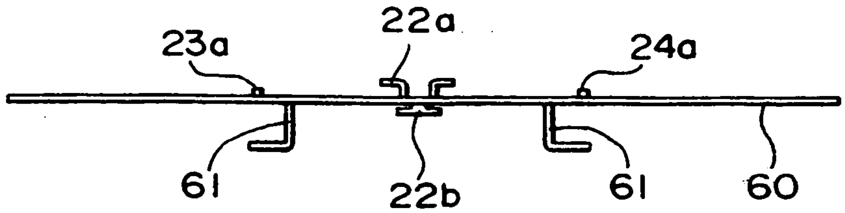
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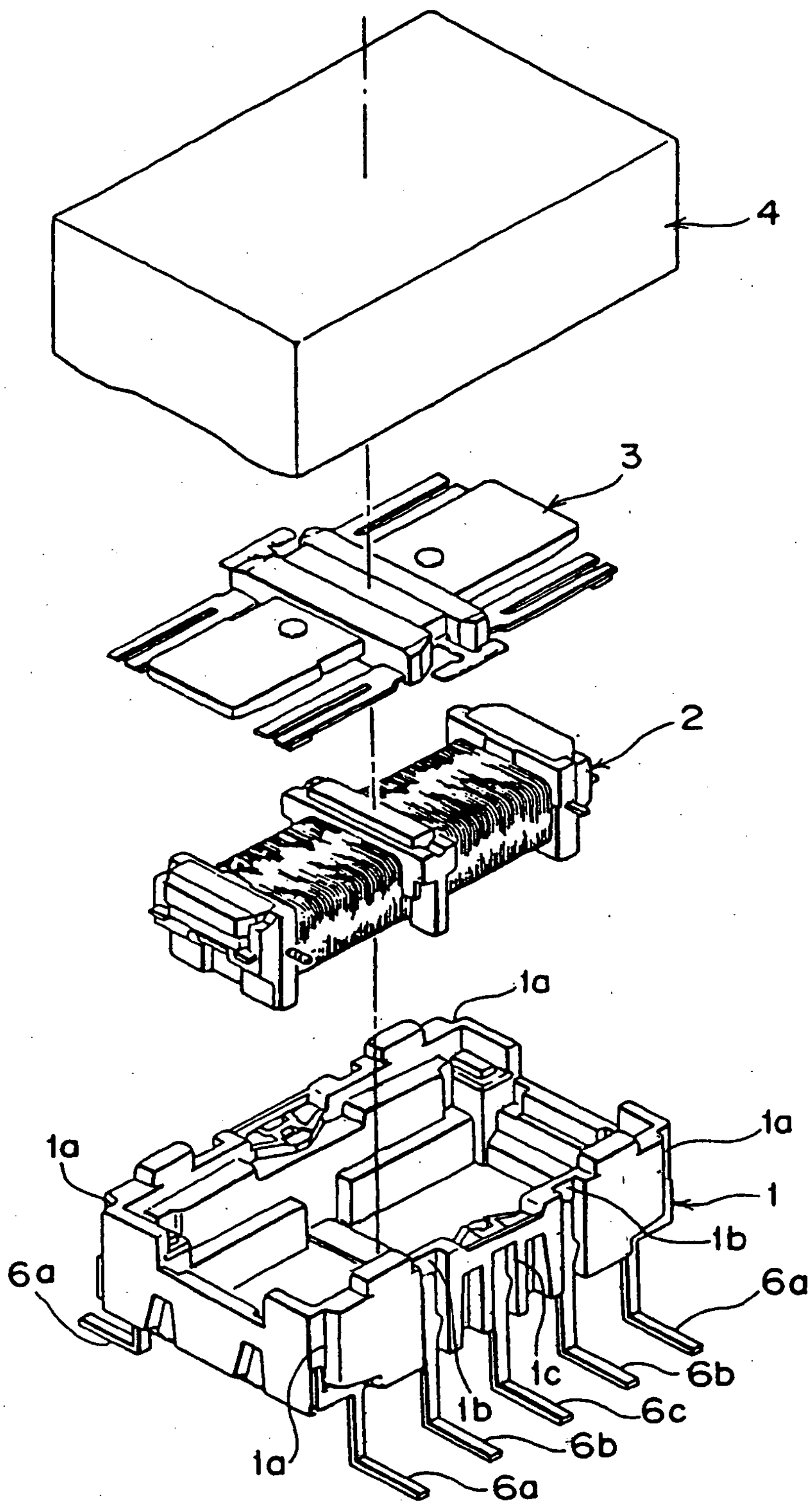
Fig. 28



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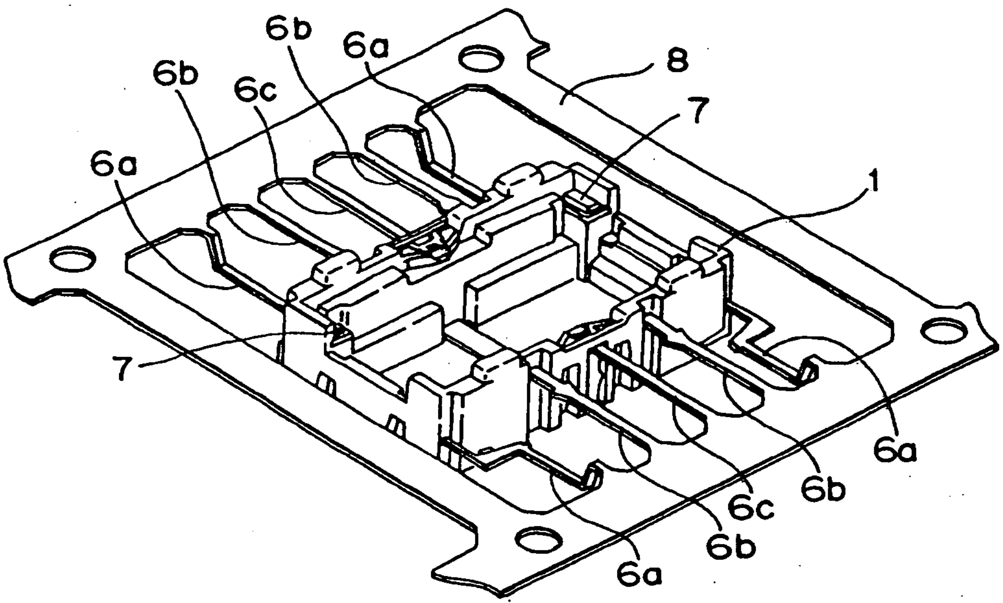


Fig. 30

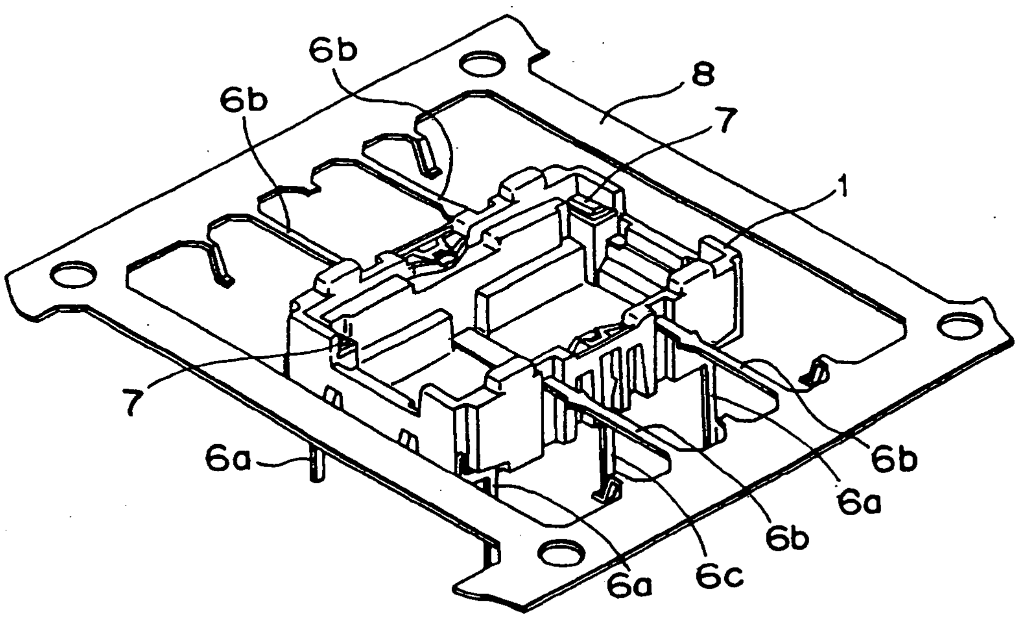
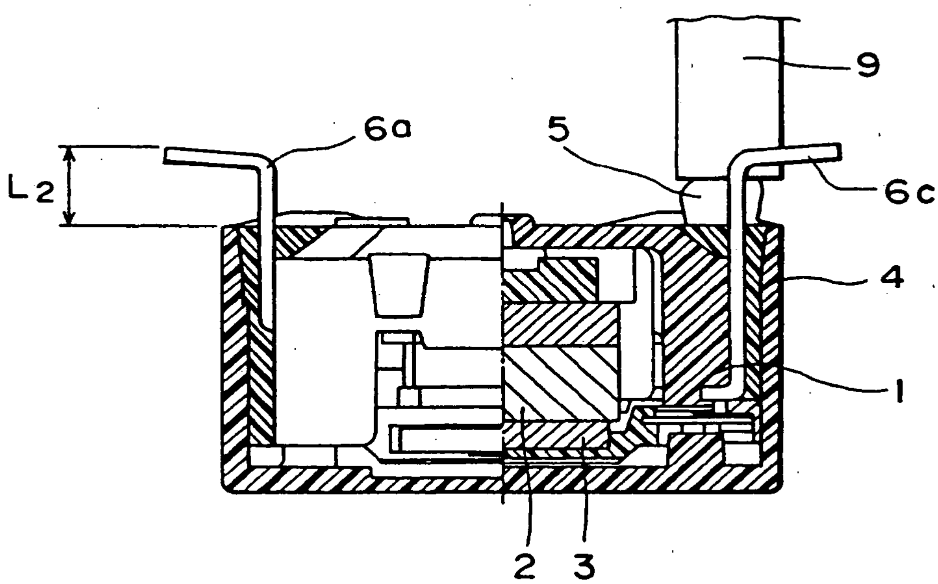


Fig. 31



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/01521

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^5 H01H50/04, H01H49/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^5 H01H50/04, H01H50/02, H01H50/14, H01H49/00, H01H51/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1994
Kokai Jitsuyo Shinan Koho 1971 - 1994

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, A, 2-503844 (Ped Ltd.), November 8, 1990 (08. 11. 90) & GB, A, 8714058 & GB, A, 8716287 & GB, A, 8809714 & WO, A1, 8810505 & AU, A1, 1943988 & ZA, A, 8803927 & EP, A1, 363410	1, 3 2, 4
Y A	JP, A, 4-149924 (NEC Corp., Tohoku NEC Co., Ltd.), May 22, 1992 (22. 05. 92), (Family: none)	2, 4, 6 12
Y A	JP, A, 4-192236 (Myojo Denki K.K.), July 10, 1992 (10. 07. 92), (Family: none)	2, 4, 7 12
A	JP, A, 55-93624 (Omron Corp.), July 16, 1980 (16. 07. 80), (Family: none)	5
Y	JP, U, 2-56333 (NEC Corp.), April 24, 1990 (24. 04. 90), (Family: none)	6, 7

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
November 25, 1994 (25. 11. 94)	December 20, 1994 (20. 12. 94)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/01521

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, U, 58-65736 (Omron Corp.), May 4, 1983 (04. 05. 83), (Family: none)	8 9
Y	JP, A, 58-169838 (NEC Corp.), October 6, 1983 (06. 10. 83), (Family: none)	9
A	JP, U, 61-70347 (Omron Corp.), May 14, 1986 (14. 05. 86), (Family: none)	10
X Y	JP, A, 3-163721 (Omron Corp.), July 15, 1991 (15. 07. 91), (Family: none)	1, 3 2, 4
X Y	JP, B2, 62-46935 (Omron Corp.), October 5, 1987 (05. 10. 87), (Family: none)	1, 3 2, 4
X	JP, B2, 1-7959 (Omron Corp.), March 2, 1989 (02. 03. 89), (Family: none)	8, 9

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